Modular Reconfigurable C4I Interface (MRCI) Phase 1

Informal Technical Interchange (ITI)

and

Pre-Test Readiness Review (PTRR)

ITI/PTRR Agenda (1 of 3)

Time	Subject
0900-0905	Welcome and Introductions
0905-0910	Programmatic Summary
0910-0920	MRCI Background and ITI/PTRR Objectives
0920-0930	Review of Message Sets
	- Air/CTAPS [USMTF]
	- Ground/MCS [USMTF]
	- Ground/AFATDS Fire Support [USMTF and TACFIRE]
0930-1015	Mission Threads
	- AFSAF-to-AWOC-to-CTAPS (3 messages)
	- ARSAF Company Commander Command Entity-to-MCS
	- ARSAF Fire Support Command Entity to AFATDS (6 messages)
1015-1020	BREAK

ITI/PTRR Agenda (2 of 3)

Time	Subject
1020-1045	Translator Implementation
	- Overview of Operation and Initialization
	- Protocol Table Generation
	- Uniform Message Structure of Protocol Tables
	- Parsers
	- Mapping File Syntax
	- Examples of USMTF to CCSIL Mapping File
1045-1125	Communications Representation in SOMs
	- Communications Degradation Work in Progress and Current Status
1125-1140	Effects of Different Federations and RTIs on MRCI Reusability
	- Extent that MRCI is Customized for STOW and HLA C2
	- Extent that MRCI uses the same Software
	- RTI Interface Implementation Activities

ITI/PTRR Agenda (3 of 3)

Time	Subject
1140-1150	Current Test Schedules and Assessment Activities
	- Alignment with STOW
	- Alignment with HLA C2
	- MRCI Assessment Schedule [Multiple Constraint Version]
1150-1200	MRCI Master Activity Schedule
	- Re-issuance of C4I Federate SOMs [MCS, AFATDS, CTAPS]
1200	Adjourn

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Programmatic Summary

25 Nov. Joined STOW CT-4 teleconference to discuss problems with STOW RTI A which resulted in decision to postpone CT-4 until Dec 16-20.

3 Dec. Attended Orlando meeting of HLA C2 IPT to discuss the objectives and issues of the HLAC2 experiment hosted in the JSIMS JPO Conference room. Discussed SOM/FOM development of NASM/AP and EAGLE. Established Scenario Working Group scheduled to meet on Dec 18, in IDA facility.

4 Dec. Met with Joe Lacetera, MITRE, CECOM, Ft. Monmouth N.J. Discussed design for communications degradation of the MRCI. Presented and discussed the Communications Effects Server's (CES) concept of operation.

11 Dec. Traveled to Burlington Mass. for Integration Test of MRCI with ARSAF.

12 Dec. Attended HLA OMT Technical Exchange meeting and discussed issues with SOM/FOM representation.

16 Dec. Traveled to Ft. Leavenworth to Test MRCI for STOW CT-4.

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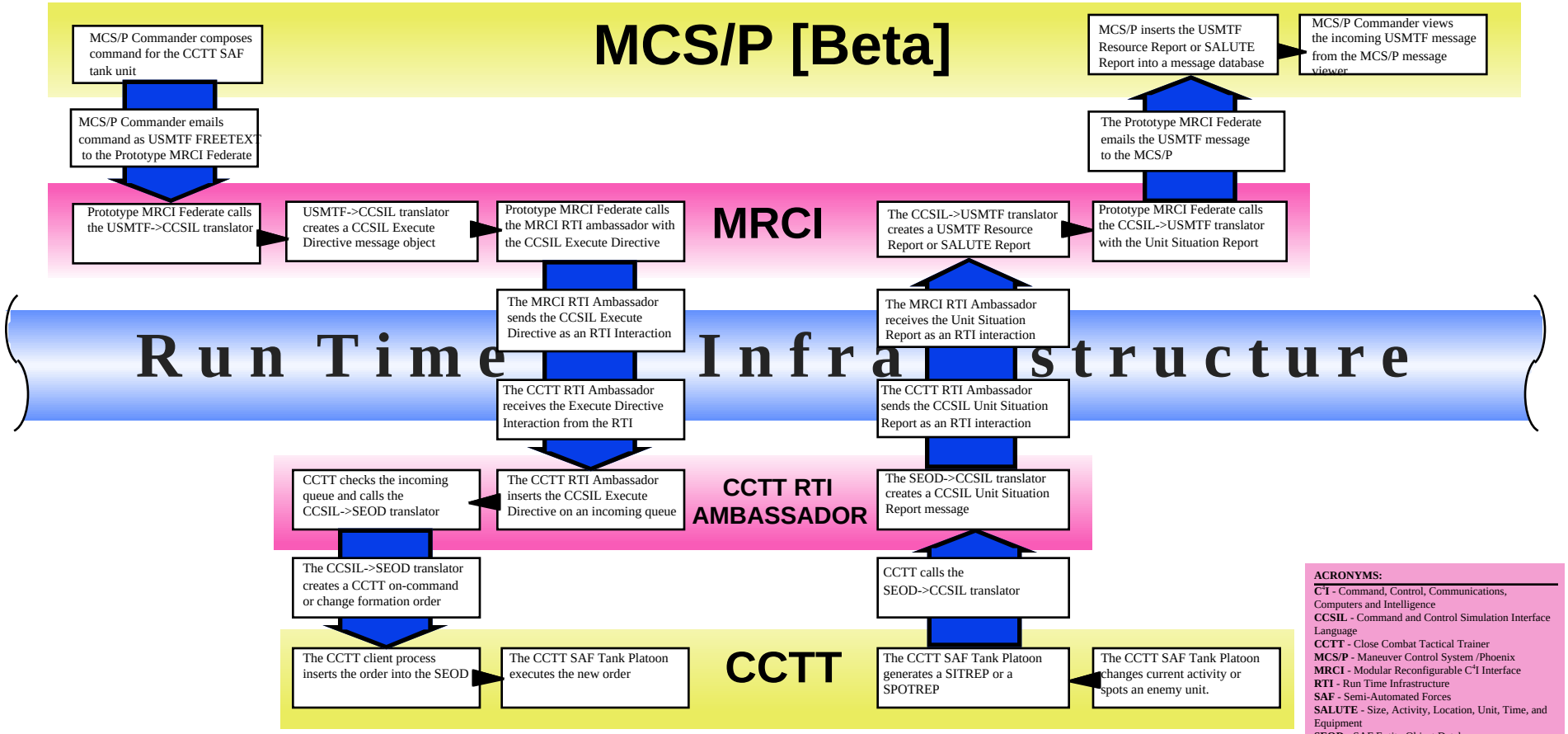
Prototype MRCI

DMSO

C4I to SAF Message Flow



ACRONYMS:
C4I - Command, Control, Communications, Computers and Intelligence
CCSIL - Command and Control Simulation Interface Language
CCTT - Close Combat Tactical Trainer
MCS/P - Maneuver Control System /Phoenix
MRCI - Modular Reconfigurable C4I Interface
RTI - Run Time Infrastructure
SAF - Semi-Automated Forces
SALUTE - Size, Activity, Location, Unit, Time, and Equipment
SEOD - SAF Entity Object Database
SPOTREP - Spot Report
USMTF - United States Message Text Format

ORDER SEQUENCE OF ACTIVITY

REPORT SEQUENCE OF ACTIVITY

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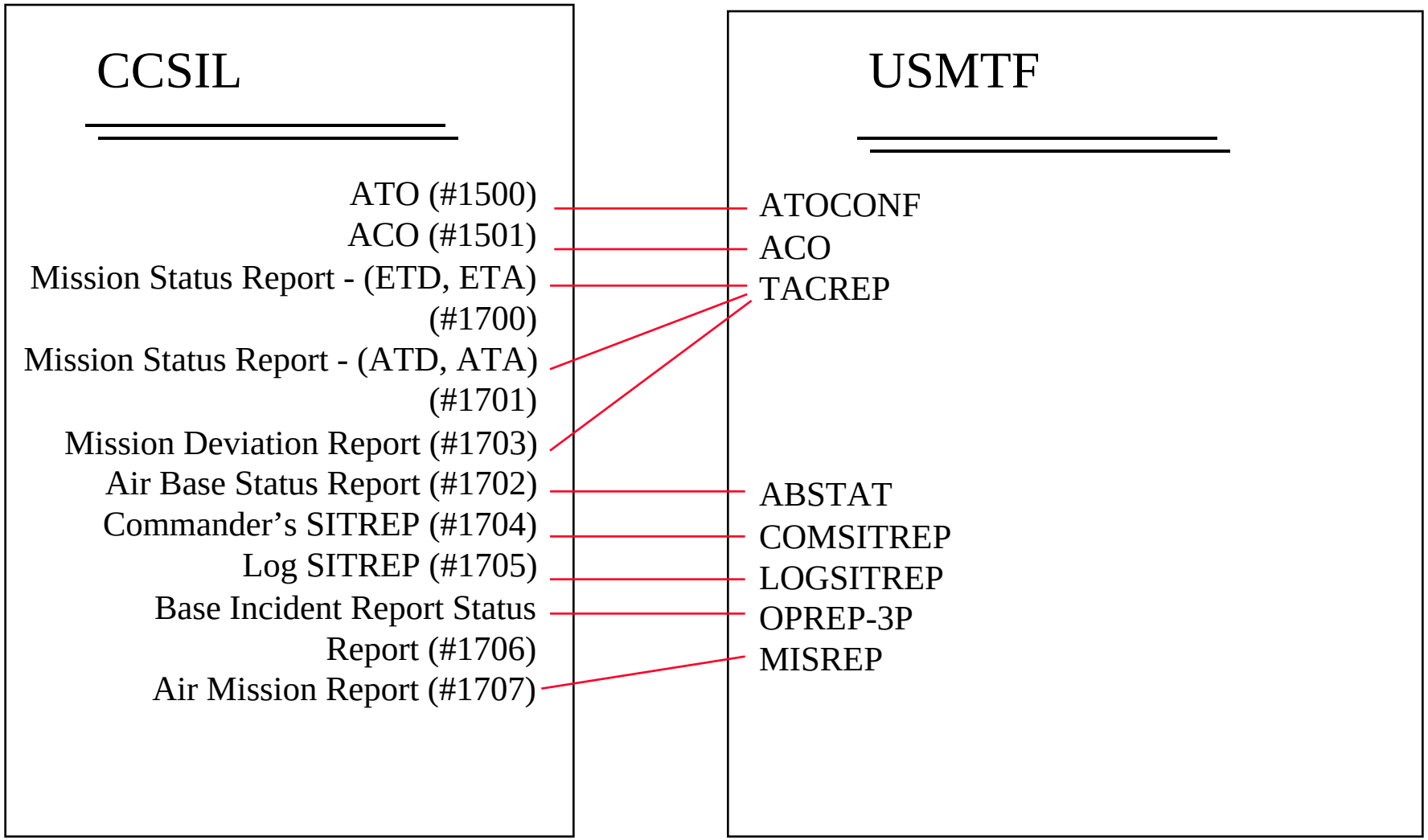
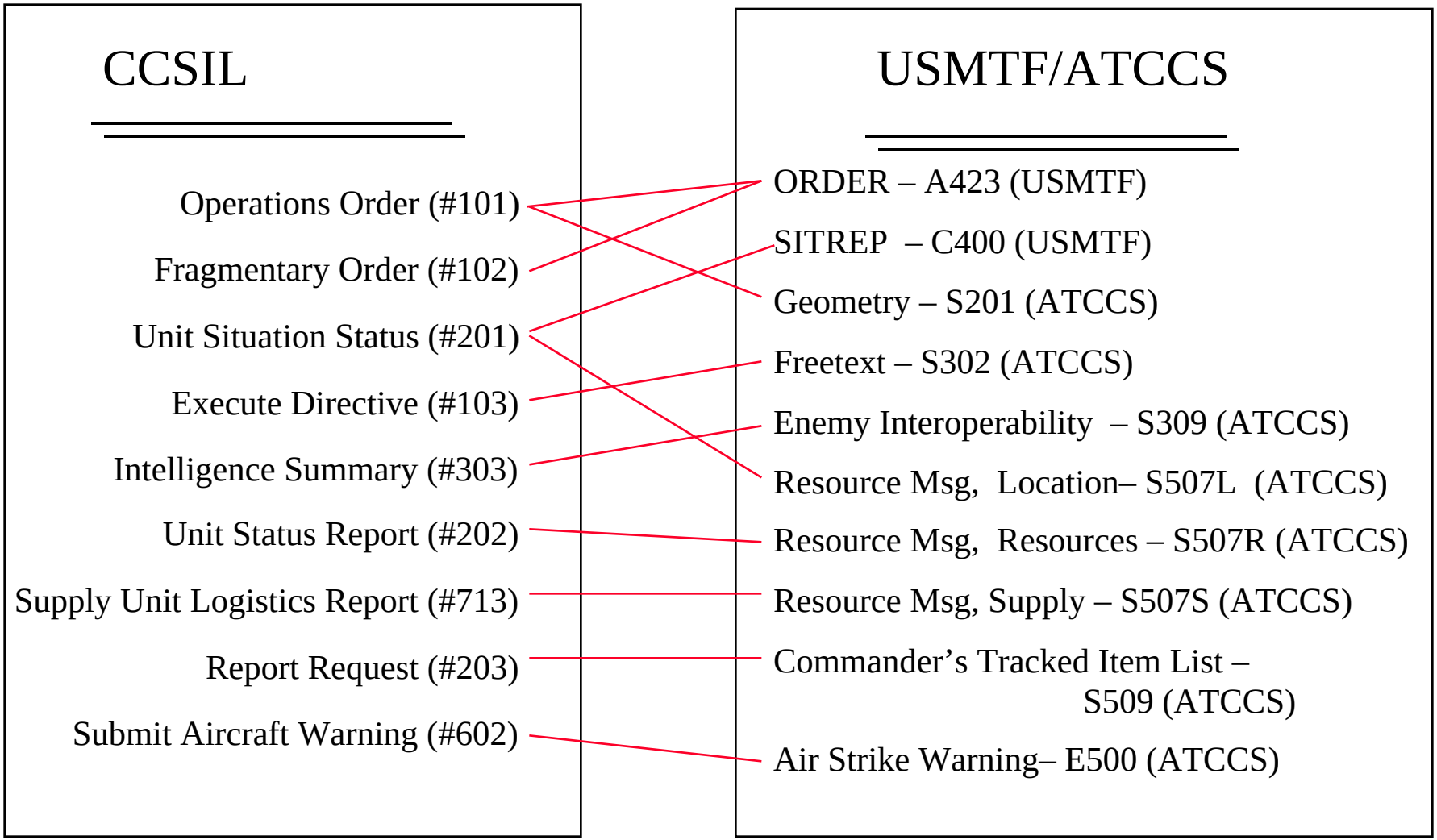
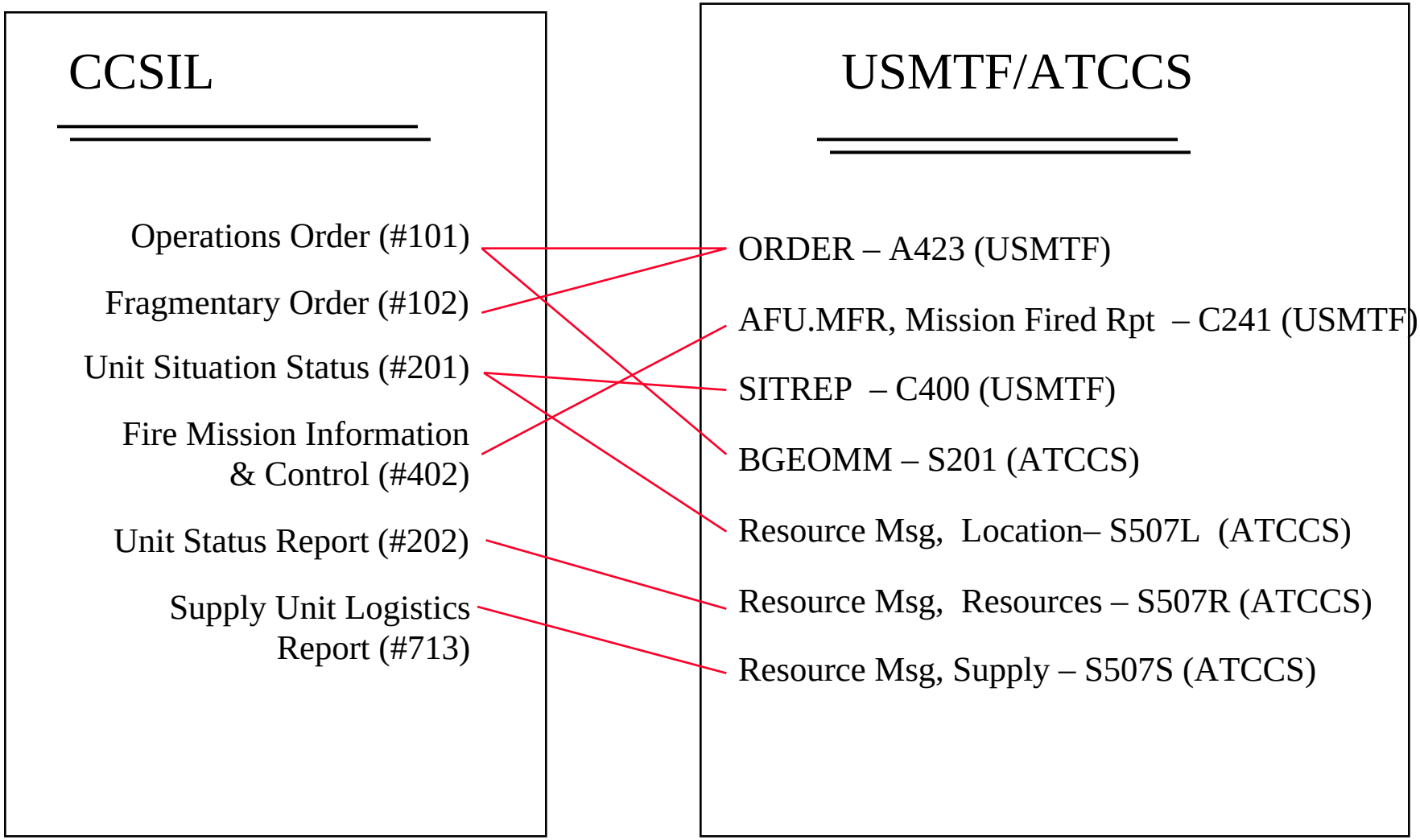
MRCI CTAPS Message Set



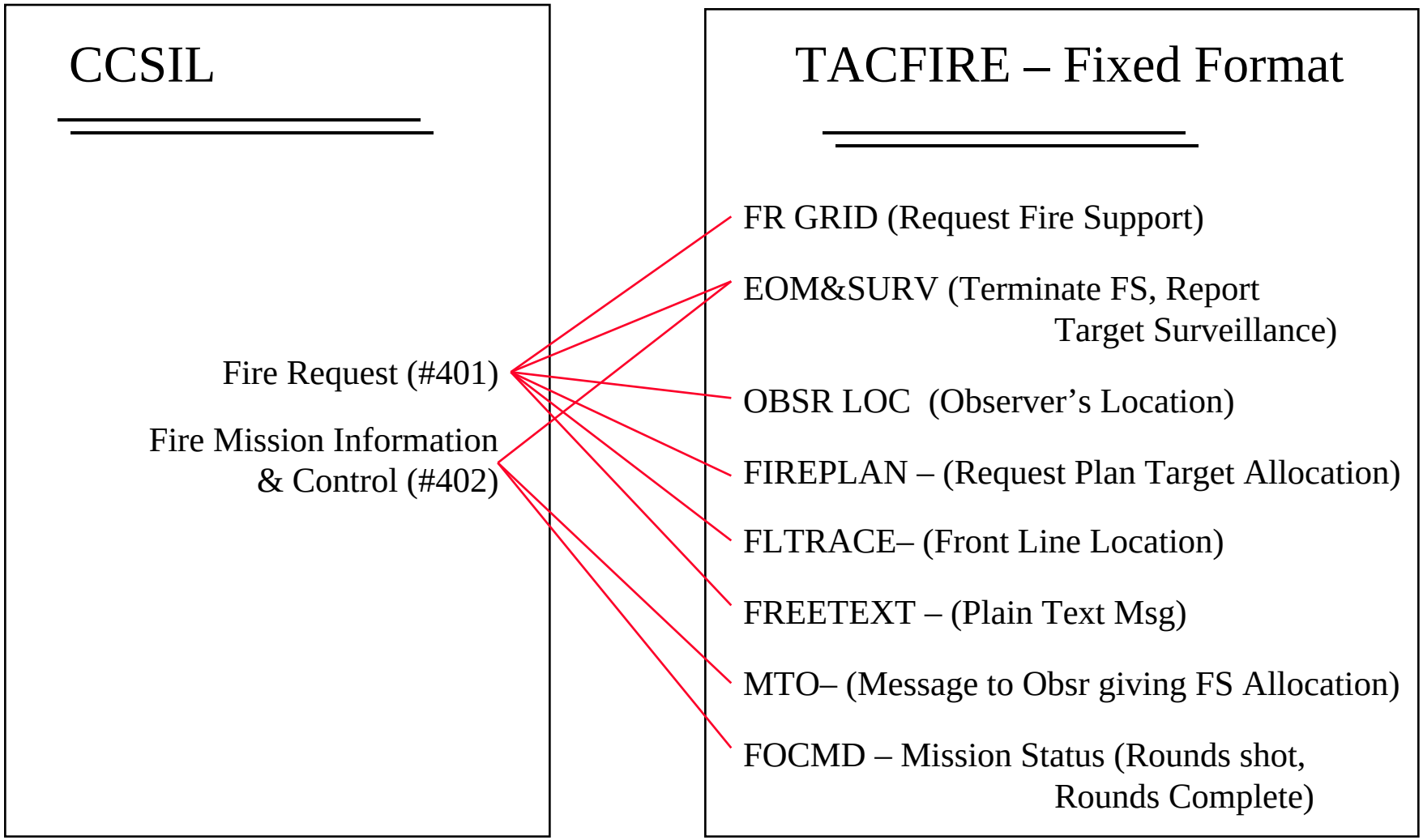
MRCI MCS Message Set



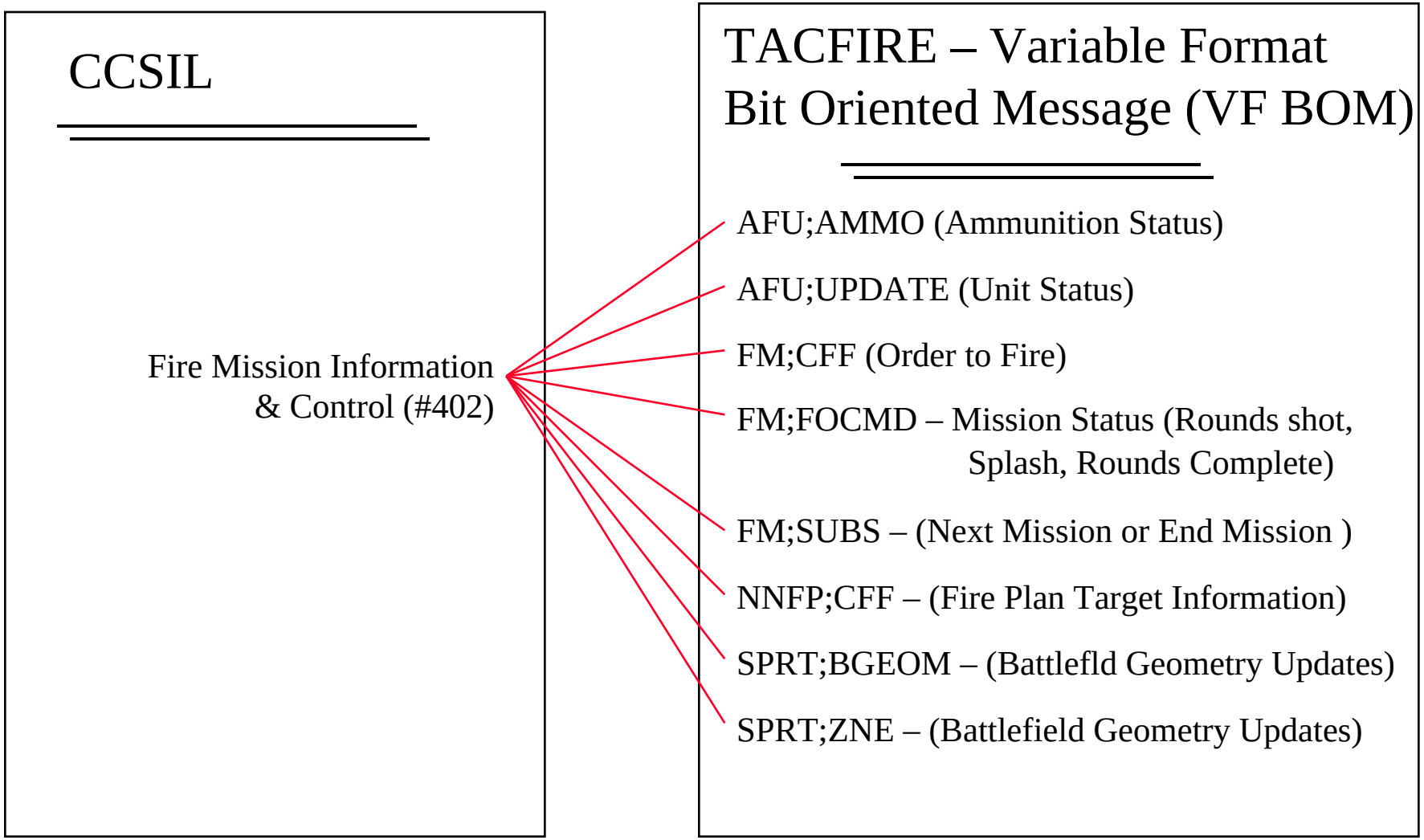
MRCI AFATDS Message Set (1 of 4)



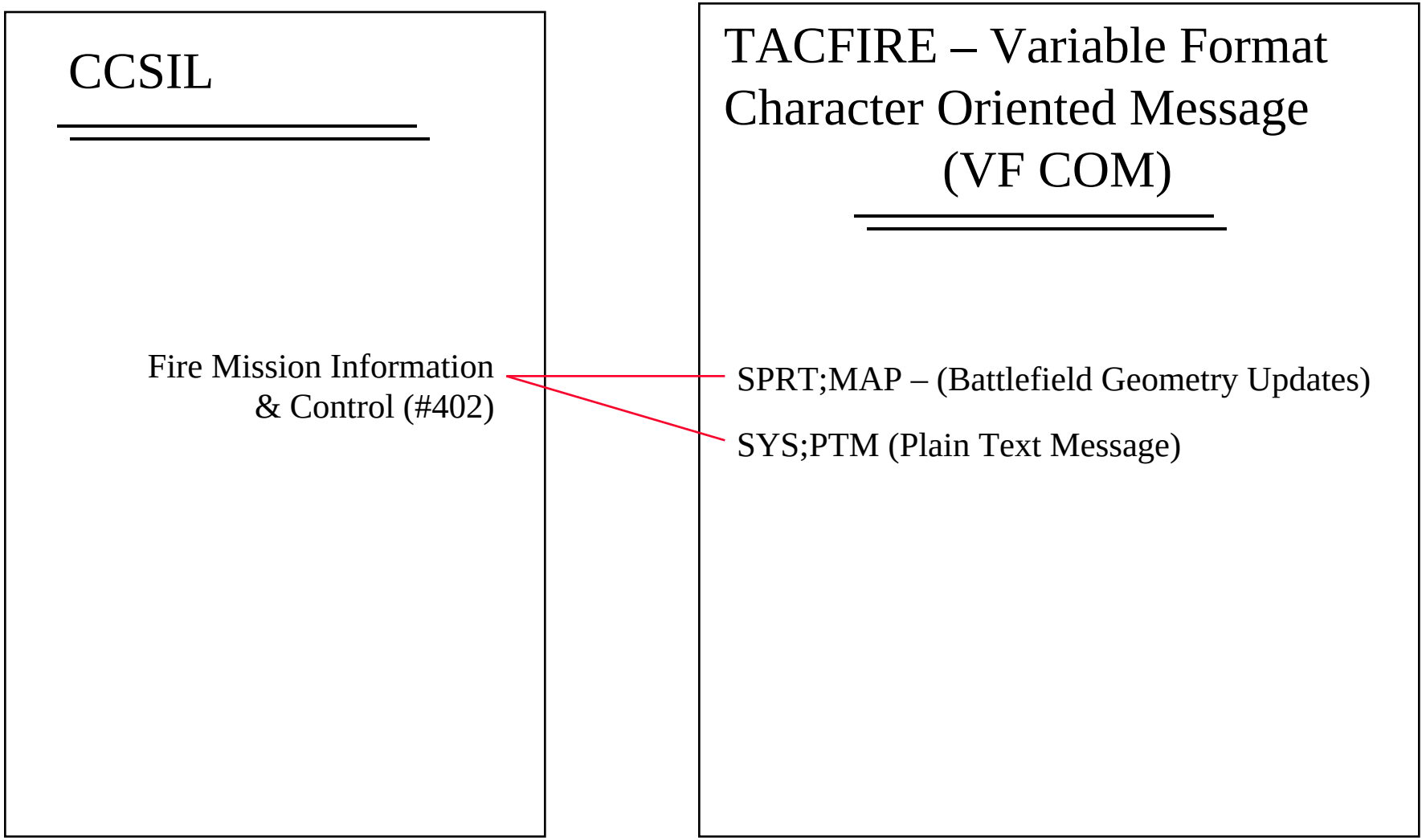
MRCI AFATDS Message Set (2 of 4)



MRCI AFATDS Message Set (3 of 4)



MRCI AFATDS Message Set (4 of 4)



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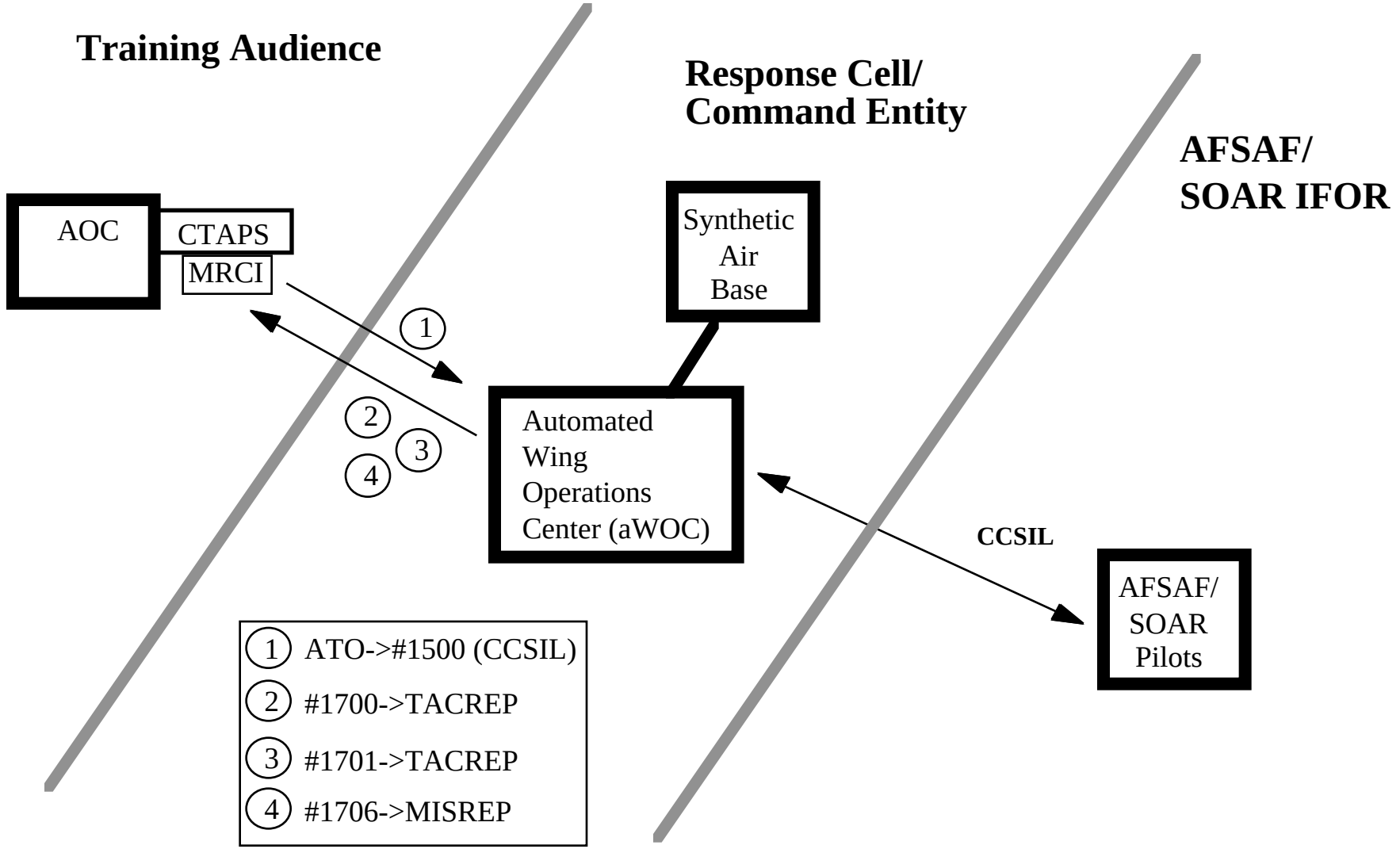
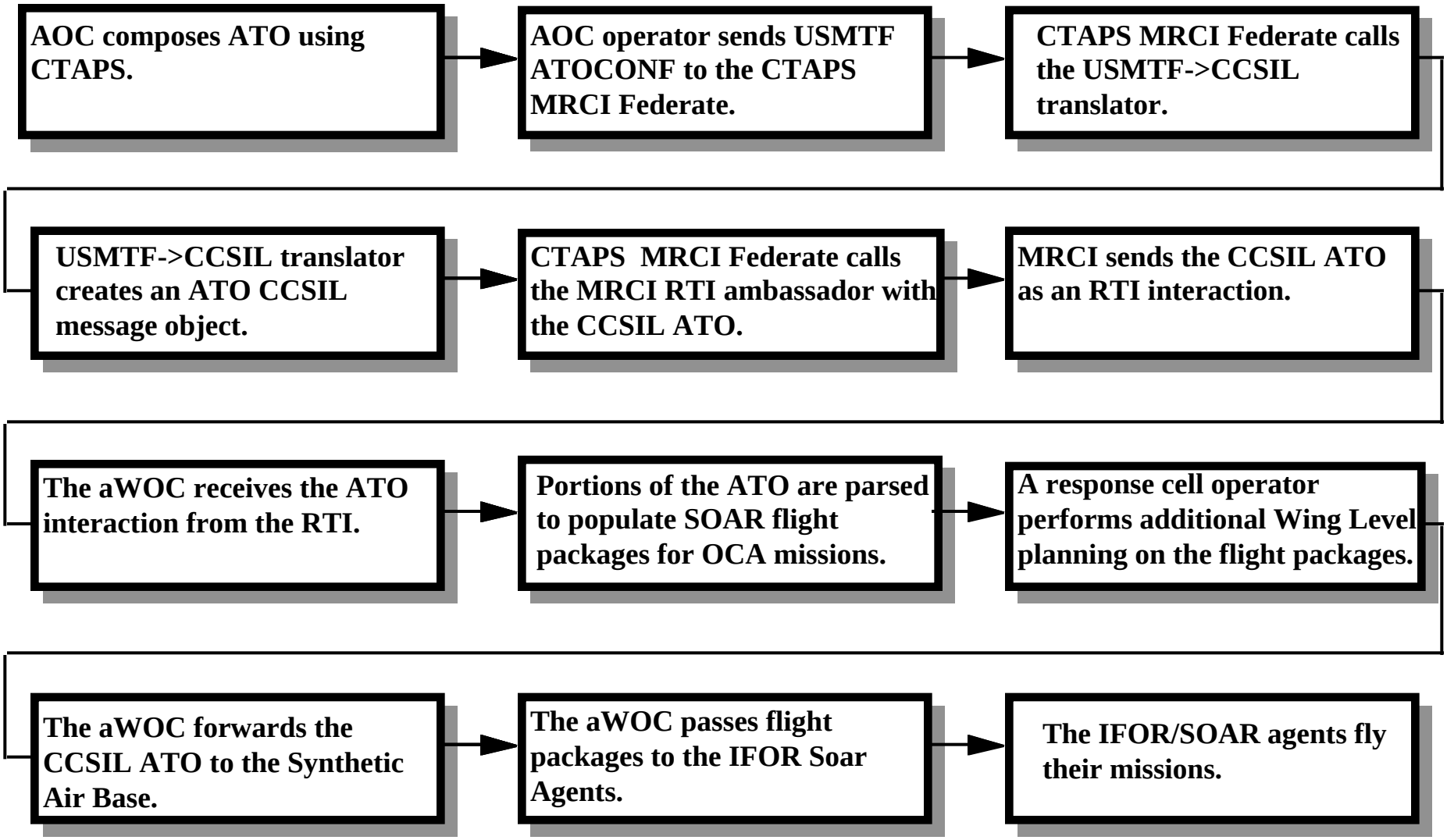
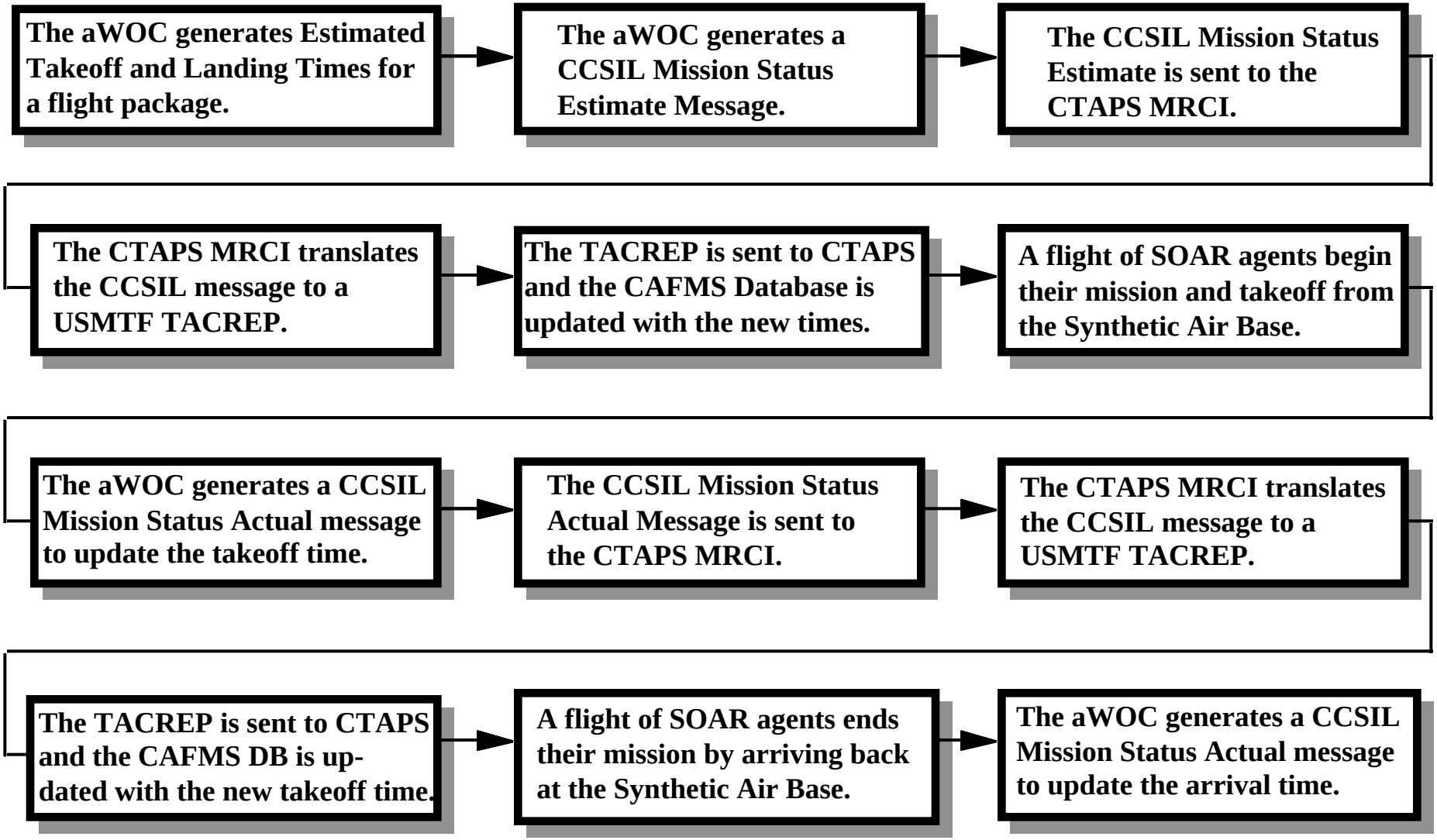
AFSAF-CTAPS Message Interaction



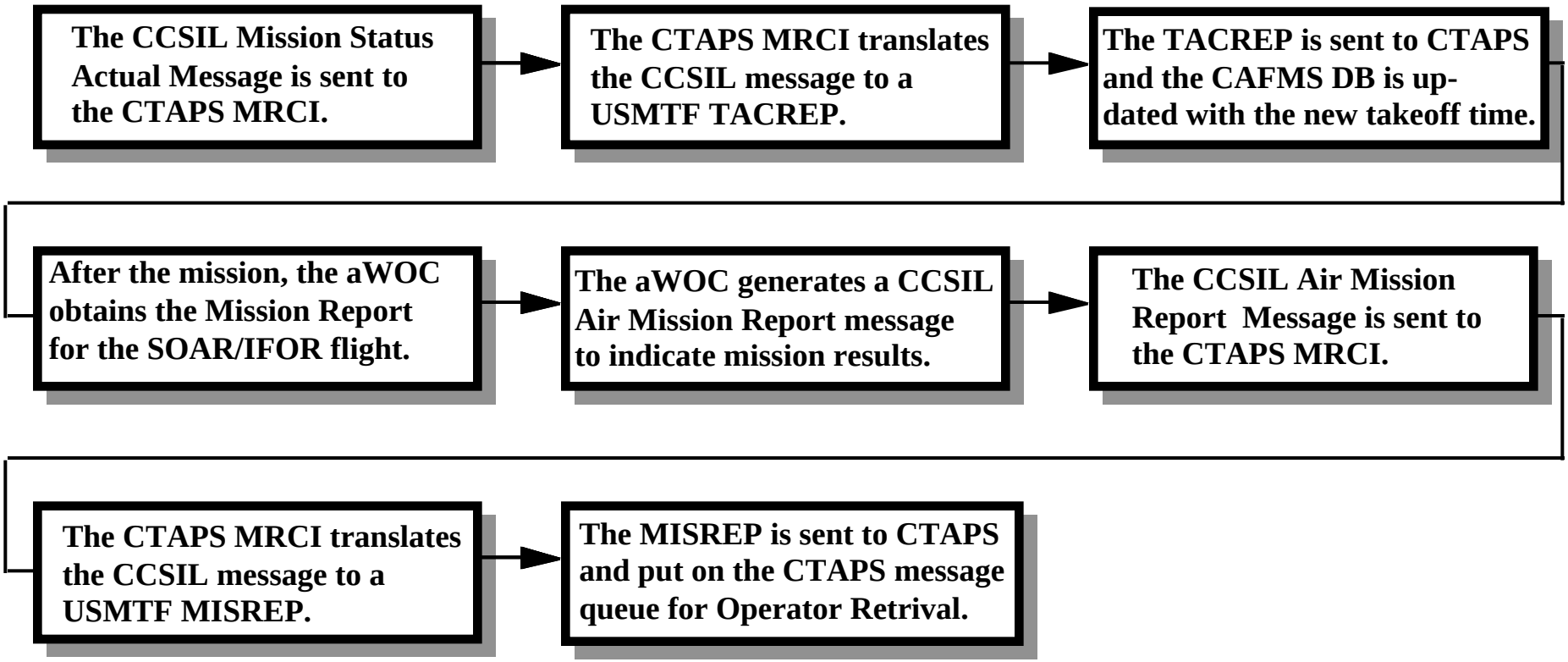
CTAPS to AFSAF: Order Activity Sequence



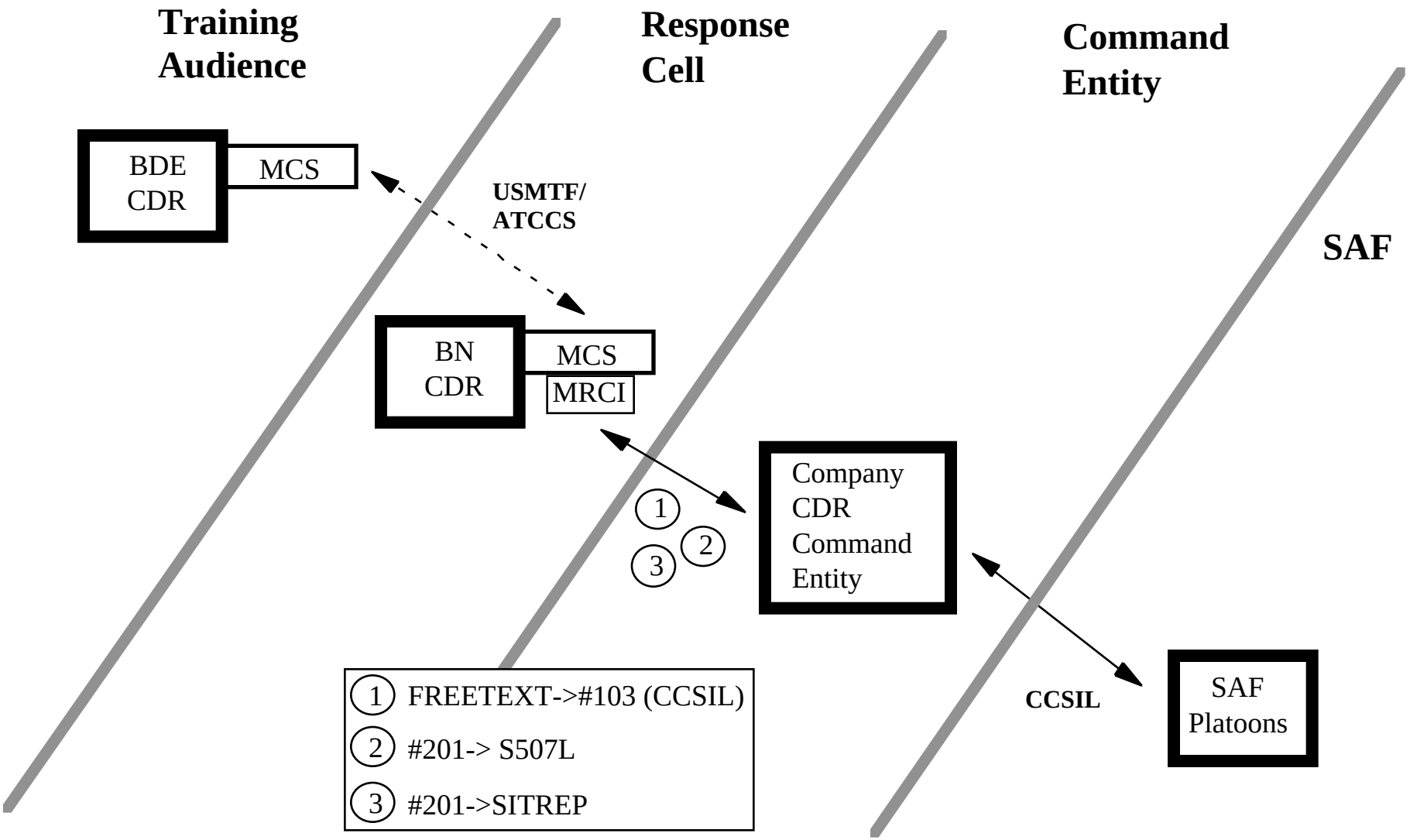
AFSAF to CTAPS: Report Activity Sequence (1 of 2)



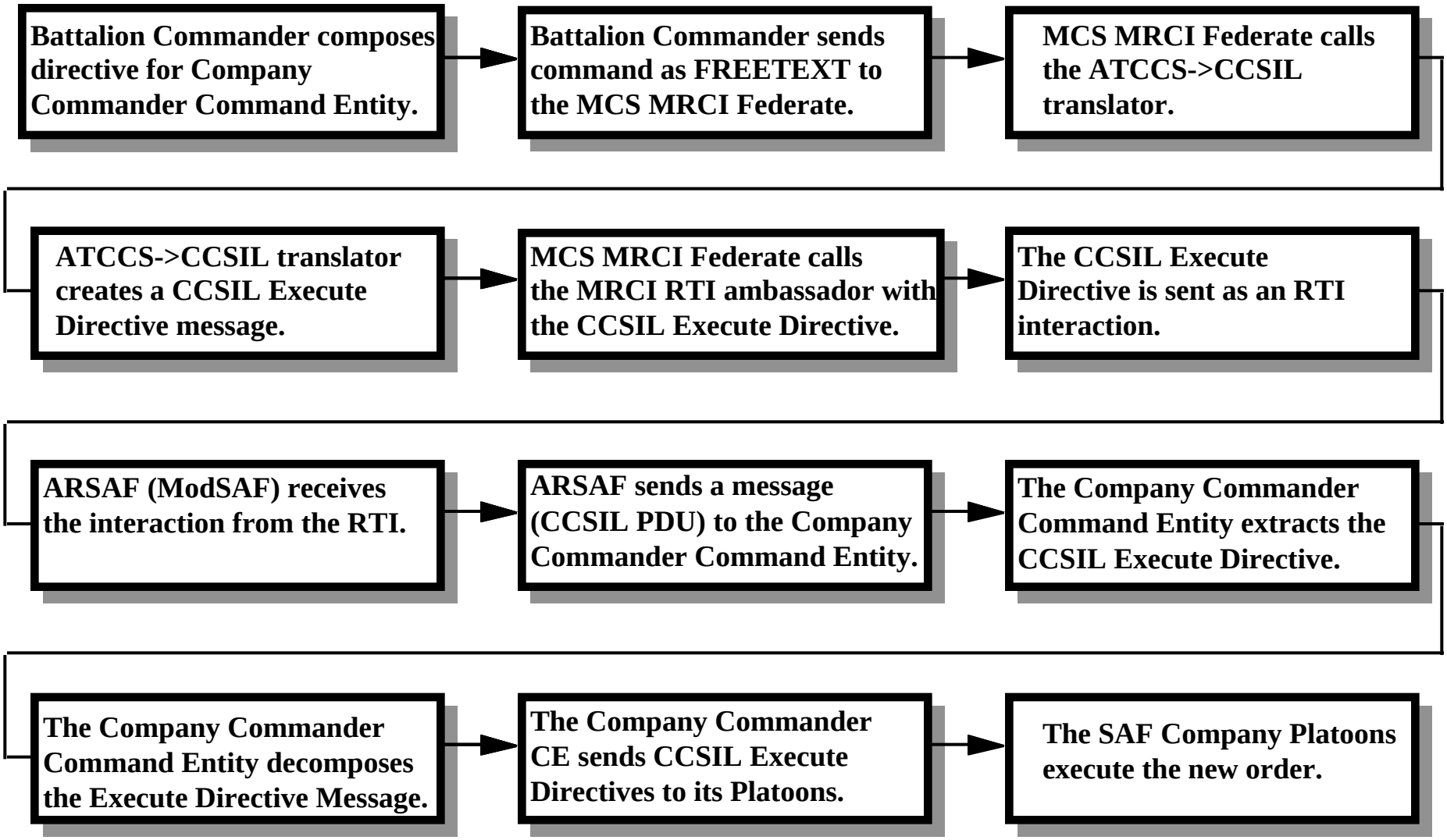
AFSAF to CTAPS: Report Activity Sequence (2 of 2)



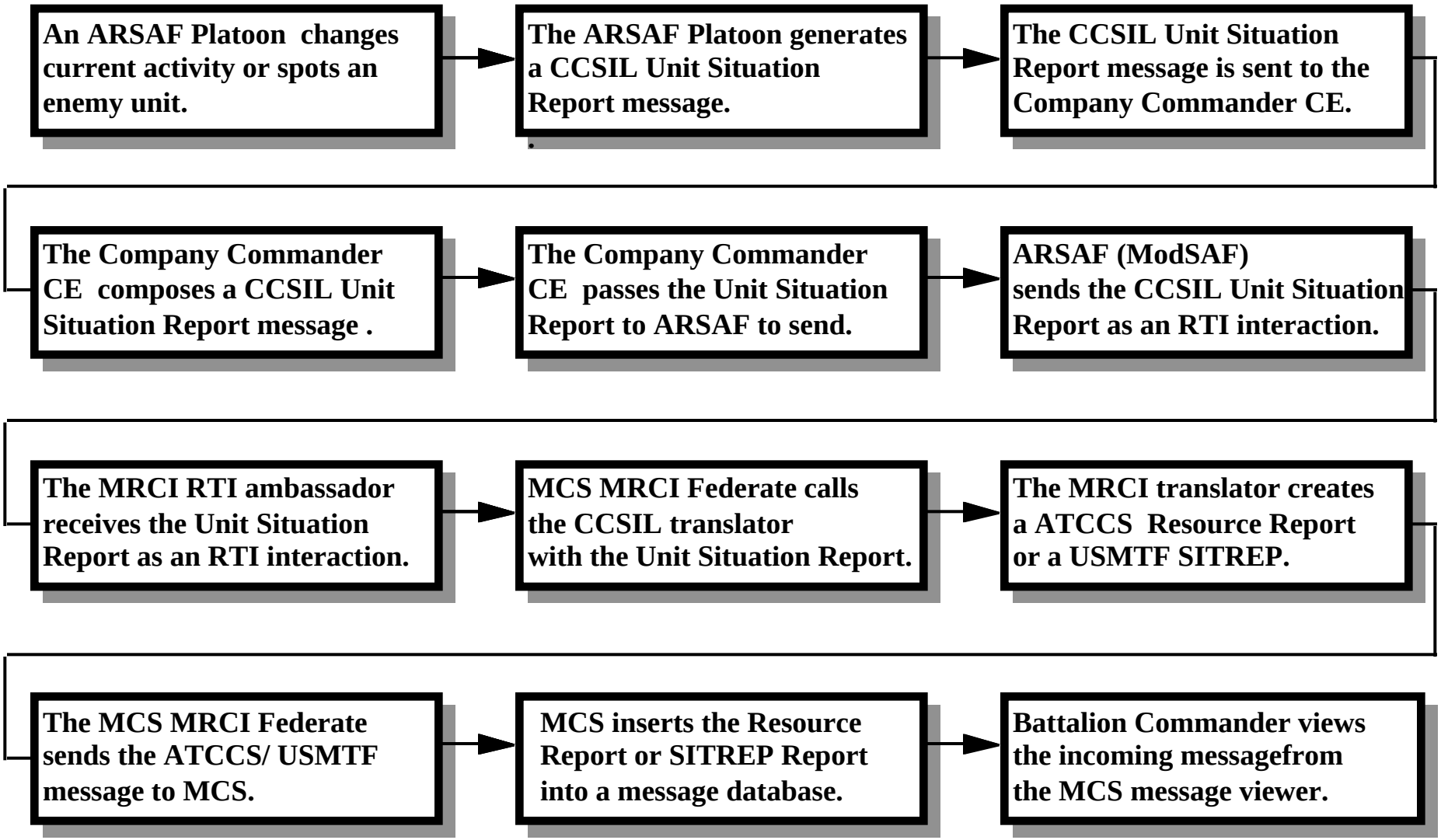
ARSAF-MCS Message Interaction



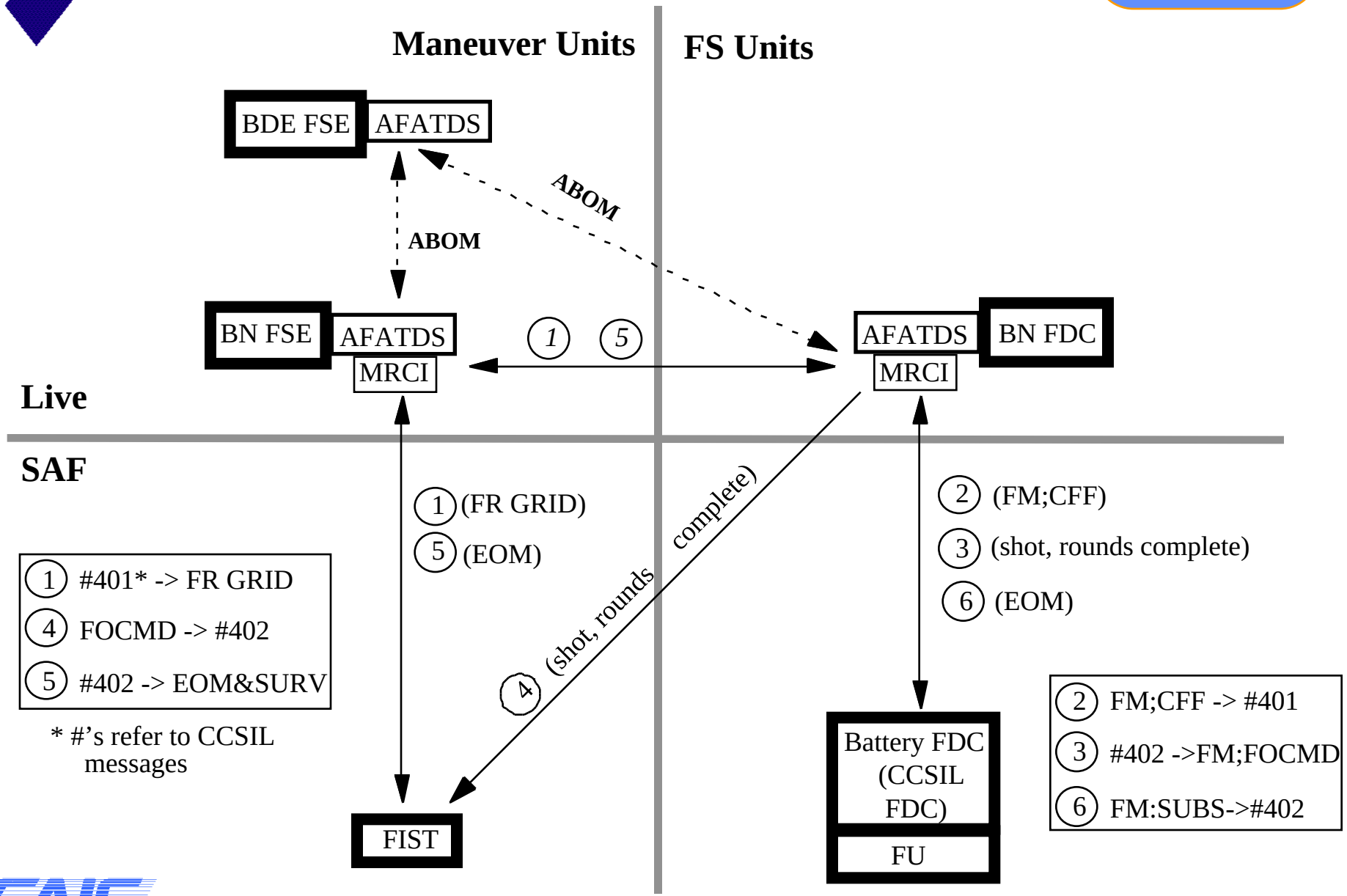
MCS to ARSAF: Order Activity Sequence



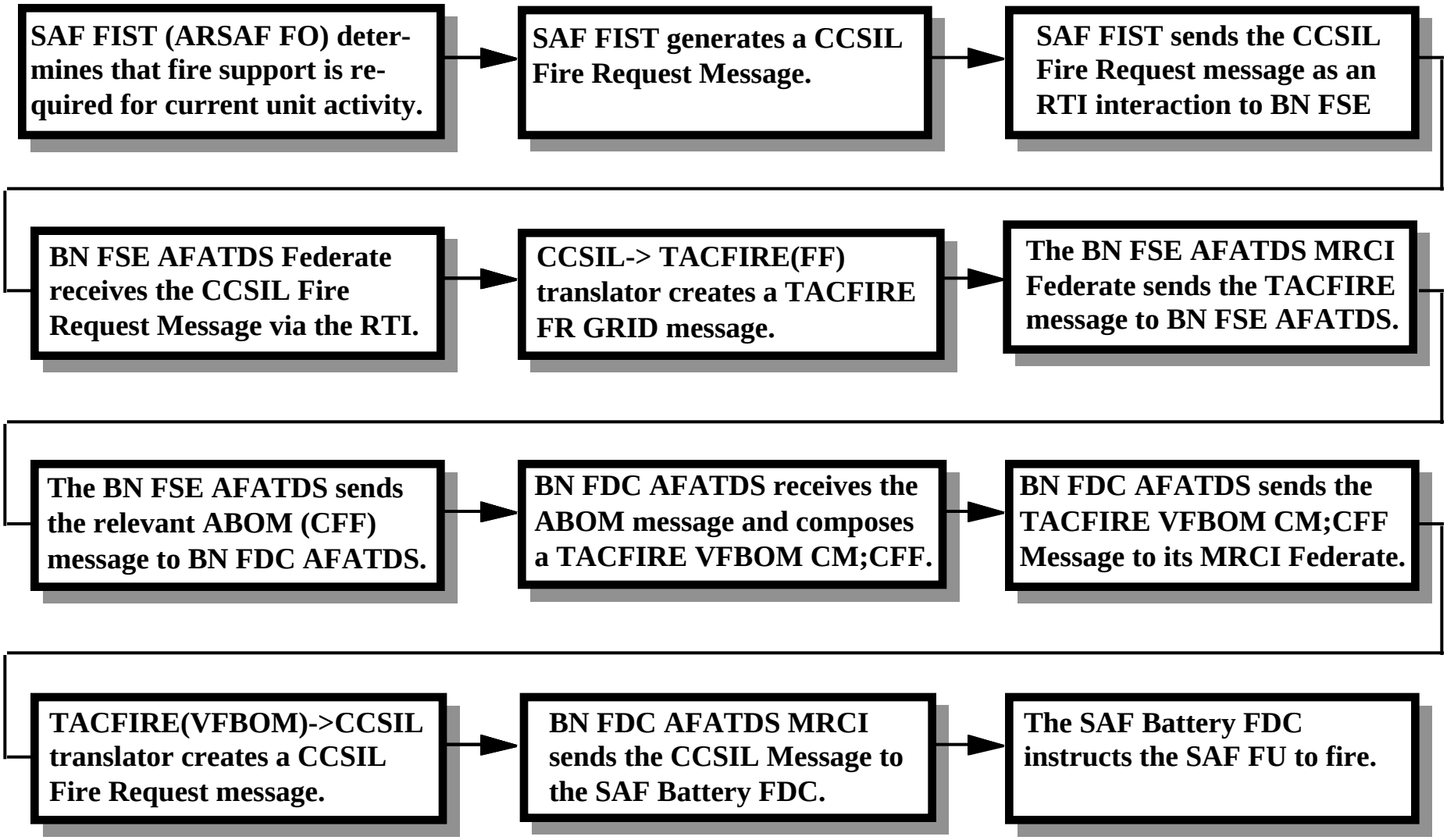
ARSAF to MCS : Report Activity Sequence



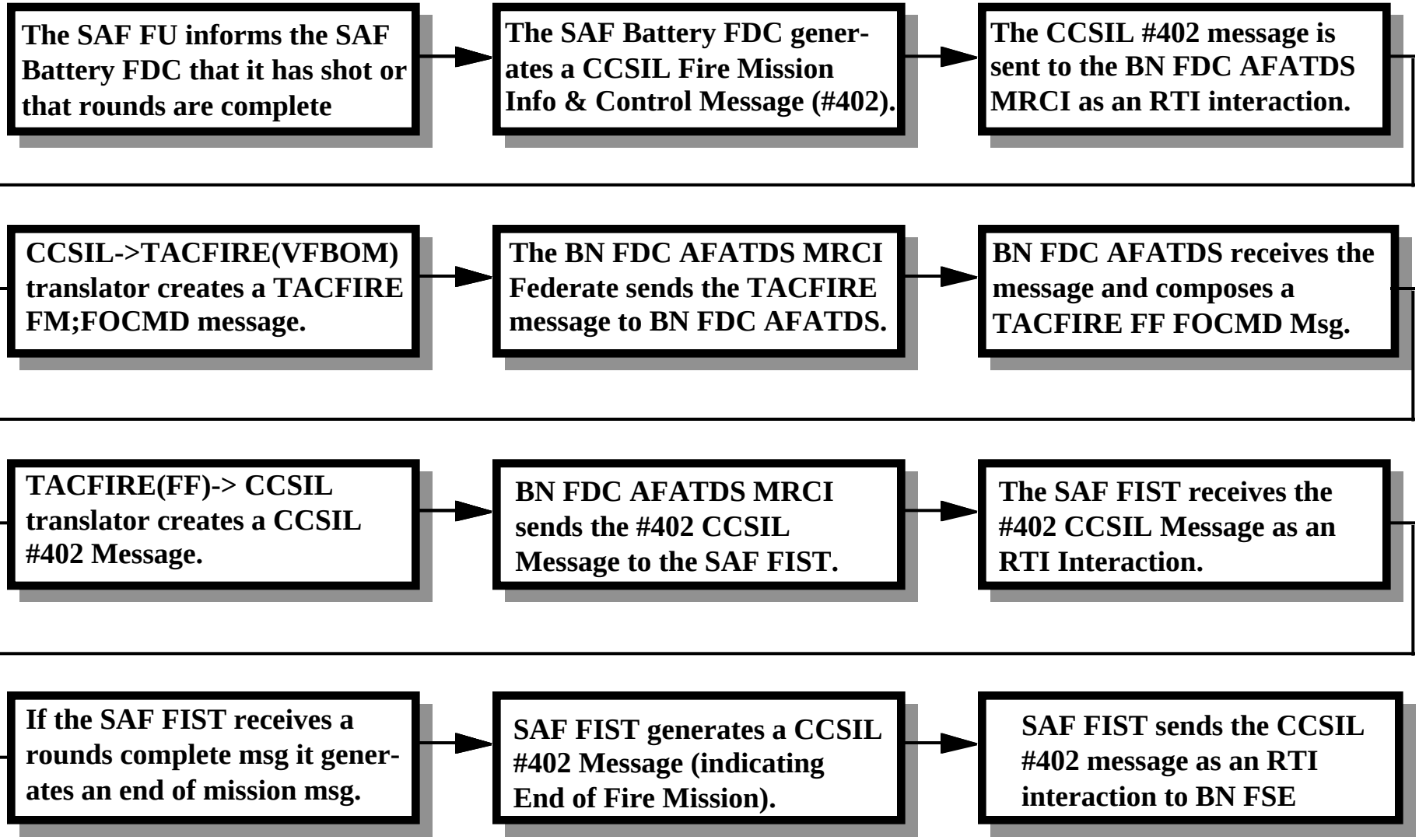
ARSAF-AFATDS Message Interaction



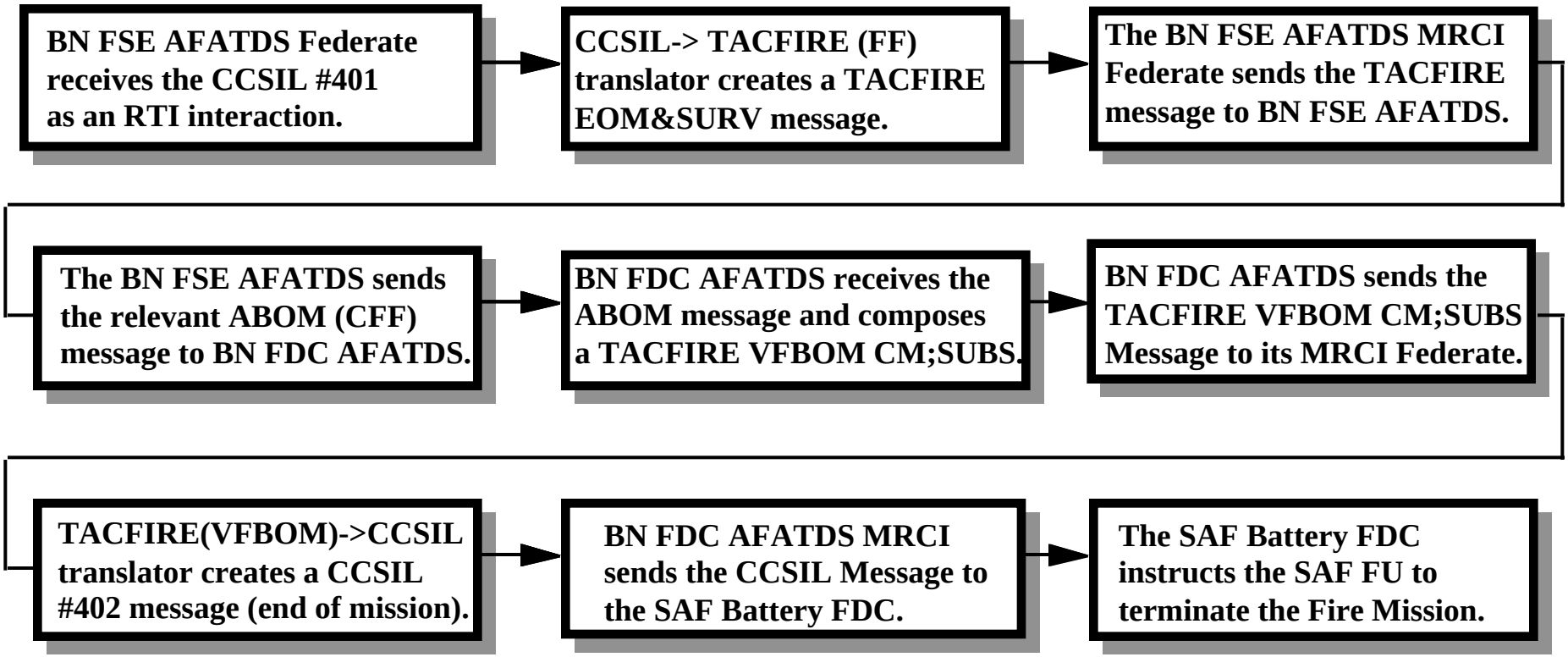
AFATDS to ARSAF:
Fire Support Activity Sequence (1 of 3)



AFATDS to ARSAF:
Fire Support Activity Sequence (2 of 3)



AFATDS to ARSAF:
Fire Support Activity Sequence (3 of 3)



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Modular Reconfigurable Message Translation (MRMT)

- MRMT takes a lifecycle approach with a flexible design to accommodate the addition of new message formats and the revision of currently utilized message formats.
- MRMT has Three Phases
  - Protocol Preparation

    The Protocol Table Generation Routines and Parser modules are created for a new message format.
  - Exercise Preparation

    Mapping files are prepared for the particular messages utilized in the exercise
  - Initialization

    Message structures are read from the protocol tables and translation objects are created from the mapping files

Generation of MRMT Protocol Tables

- To utilize a new message protocol, a new module must be written to take database or ascci files describing the message structures and translate them into MRMT protocol tables

- We have currently done this for two protocols:

  – USMTF

  The following Ingress database files were used as the input to the USMTF Table Generation Module (current USMTF files are available on CD): fudbasic.ing, fudcolht.ing, fudname.ing, msgid.ing, msgmane.ing, msgsetor.ing, setfield.ing, settitle.ing, snrmks.ing, and setrmks.ing

  – CCSIL

  The following ascci files were used as the input to the CCSIL Table Generation Module : cfor.x and cfor_enum.x

MRMT Uniform Message Structure

- Protocol tables have data structures for messages, fields and enumerations
- An abstract description of the structures is:

Message_rec:

name,
serial_id,
entry_node,
next_node

Field_rec:

label,
control_flag,
sequence,
byte offset,
min_size
max_size
data_type
msg_data
msg_link_ptr
leaf_ptr
next_ptr
repeat_on

Enumeration_rec:

name,
list_size
data_list
next_node

DMSO

MRMT Parsers

- Each Protocol must have a message parser that can both put a message into the MRMT uniform message structures and construct a message from the uniform message structures

- Currently, parsers for USMTF (character oriented) and CCSIL (binary) have been constructed.

Mapping File Syntax

For each pair of messages, there is an initial line beginning with the letter T followed by a delimiter (|), a to_message_name (or ID), a delimiter (|), a from _message name (or ID). After the first line, there are multiple mapping lines. A mapping line contains an opcode for translation, followed by a delimiter (|), and one or more operands. The operand following the opcode will be the to_field of the to_message. The opcode will determine the number of the operands. An operand is the data accessing Id to access an field in a message

Operand:

1,2:	**1 – access by position, position is "2"**
2,MSNDAT:	**2 – access by field name, name is "MSNDAT"**

Opcode *(Preliminary Set)*:

1 : same data type mapping. Requires msg fields as operands.

2 : string to number (float) mapping. Requires msg fields as operands.

3 : default. Map to constant.

10 : string concatenation. Requires two or more string msg fields as operands.

11 : string concatenation with pattern search. Requires two or more operands.

12 : string to string maping with pattern search and then decode & encode. enumerations. Requires two operands.

USMTF to CCSIL Mapping File (1 of 2)

```
T| ccsil_mission_status|TACREP
# Comment lines start with #
# map from  message name TACREP to message name ccsil_mission_status

|1|2,originator|2,MSGID:2,def2|
# map by same type. Go to TACREP message, get the field name MSGID,
# access the field name def2 then map to field name originator of the ccsil_mission_status.

|10|2,date_time:2,hour|2,OPSUP:1,3,7,8|
# map by string concatenation. Goto TACREP message, get to the field name
# OPSUP, go down one level and get the 3rd. data field, using characters
# 7 and 8 and finally map to the field data name hour sublevel of field name
# date_time of the ccsil_mission_status message

|10|2,date_time:2,minute|2,OPSUP:1,3,9,10|
# map by string concatenation. Goto TACREP message, get to the field name
# OPSUP, go down one level and get the 3 rd. data field, using substring
# 9 and 10 and finally map to the field data name minute sublevel of field name
# date_time of the ccsil_mission_status message
```

USMTF to CCSIL Mapping File (2 of 2)

|10|2,date_time:2,day|2,OPSUP:1,3,11,12|
|10|2,date_time:2,time_zone|2,OPSUP:1,3,13,13|

|11|2,ato_identification|2,OPSUP,”SUBID:”,6,n|
map by string concatenation with pattern search.
Goto TACREP message, get to the field name
OPSUP, get the data string. Search the data string for the pattern “SUBID:”
get the substring starting at length 6 and ending at the null character.
Map to the field data name hour sublevel of field name
ato_identification of the ccsil_mission_status message

|11|2,mission_number|2,AMPN,”STATUSCODE:”,5,n|

|12|2,air_mission_status,air_mission_status|
2,AMPN,”STATUS CODE:”,1,n, air_mission_status_CAFMS|
|12|2,air_mission_status_code, air_mission_status_code |
2,AMPN,”MISSION STATUS CODE:”,1,n|
|11|2,aircraft_count|2,AMPN,”NUM ACFT FLOWN:”,1,n|

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CESS Defined

(pronounced CEASE)

The Communications Effects Server System (CESS) is a modular server system used to apply tactical communications effects in a simulated environment. The CESS operates within High Level Architecture (HLA) guidelines as defined by the Defense Modeling and Simulation Organization (DMSO).

The CESS is composed of two parts:

1) The Communications Effects Module (CEM)- A module incorporated within a system acting as a federate in an HLA exercise
2) The Communications Effects Server (CES)- A stand alone system acting as a federate in an HLA exercise

- Both components will communicate via the HLA Run Time Infrastructure (RTI).
- The Modular Reconfigurable C4I Interface (MRCI) will be the first system to integrate the CESS.

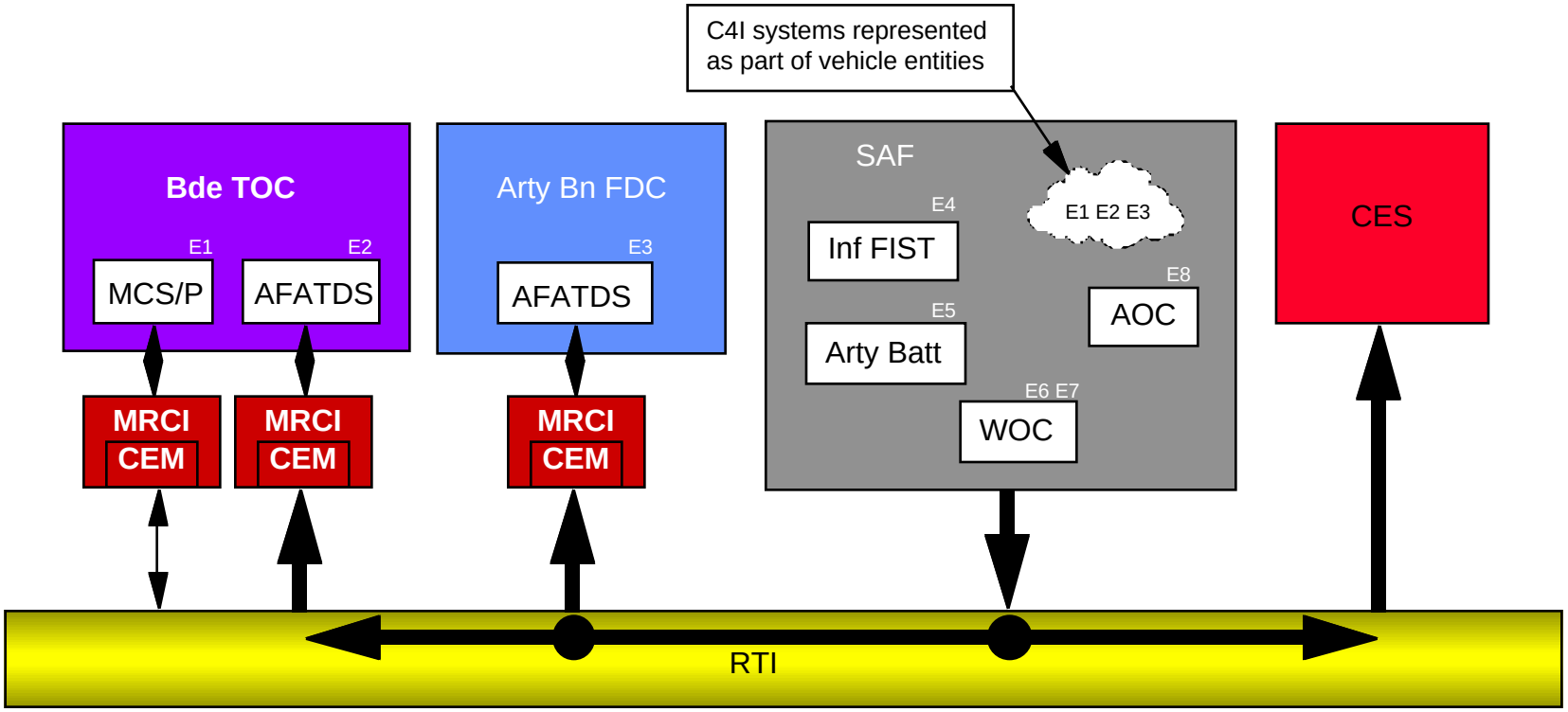
The CEM determines message delivery based on:
- communications object settings
  OR
- degradation parameters received from the CES

The CES:
- monitors aspects related to communications
  AND
- generates degradation parameters on a per message basis

Basic Concept- Part I

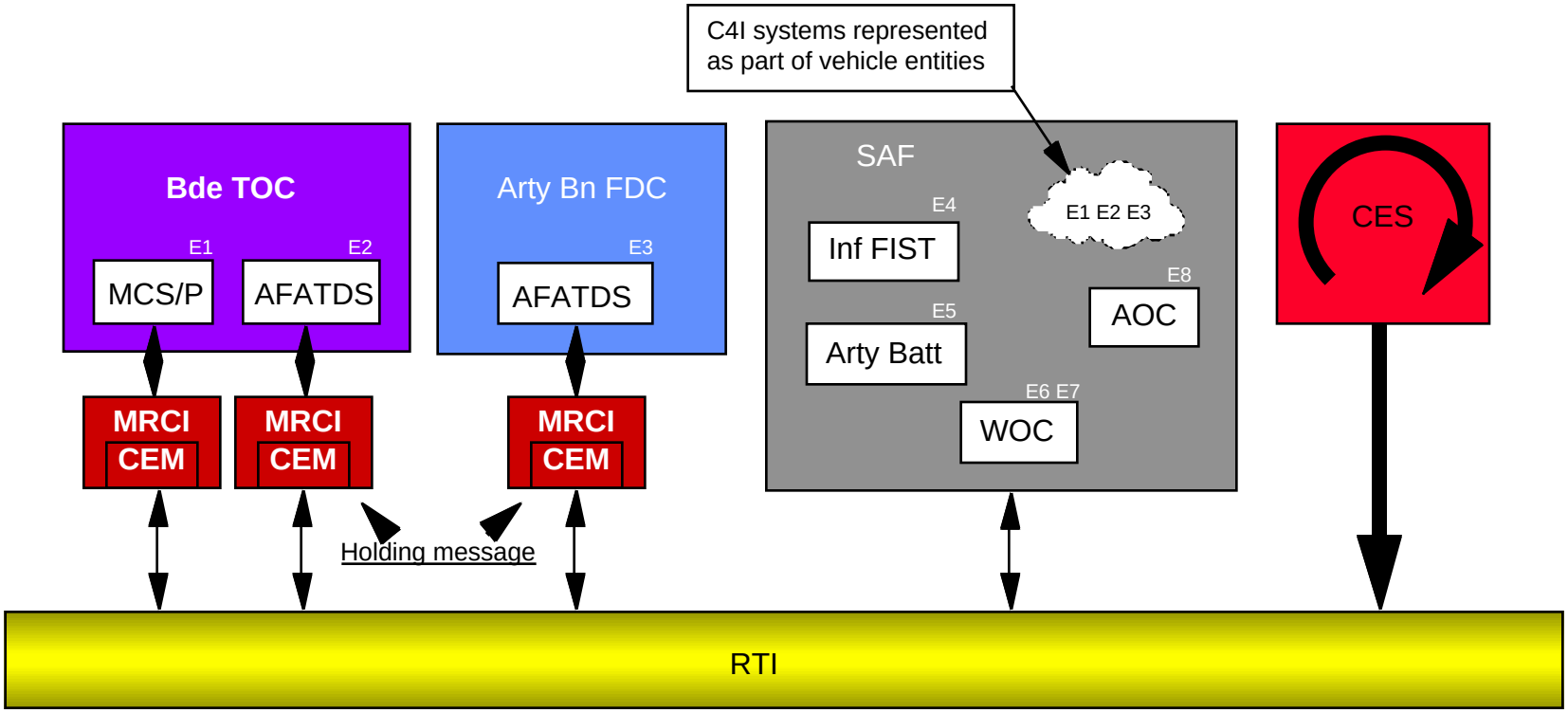
1) A message interaction is sent via the RTI
2) The message is received by federates subscribing to message interactions. Each federate determines if the message was intended for it. In this example, the message was intended for and received by:
   - The Bde TOC AFATDS system's representative MRCI
   - The Arty Bn FDC AFATDS system's representative MRCI

   But, because the Communications Effects Server (CES) is interested in all message interactions, it receives the interaction as well.



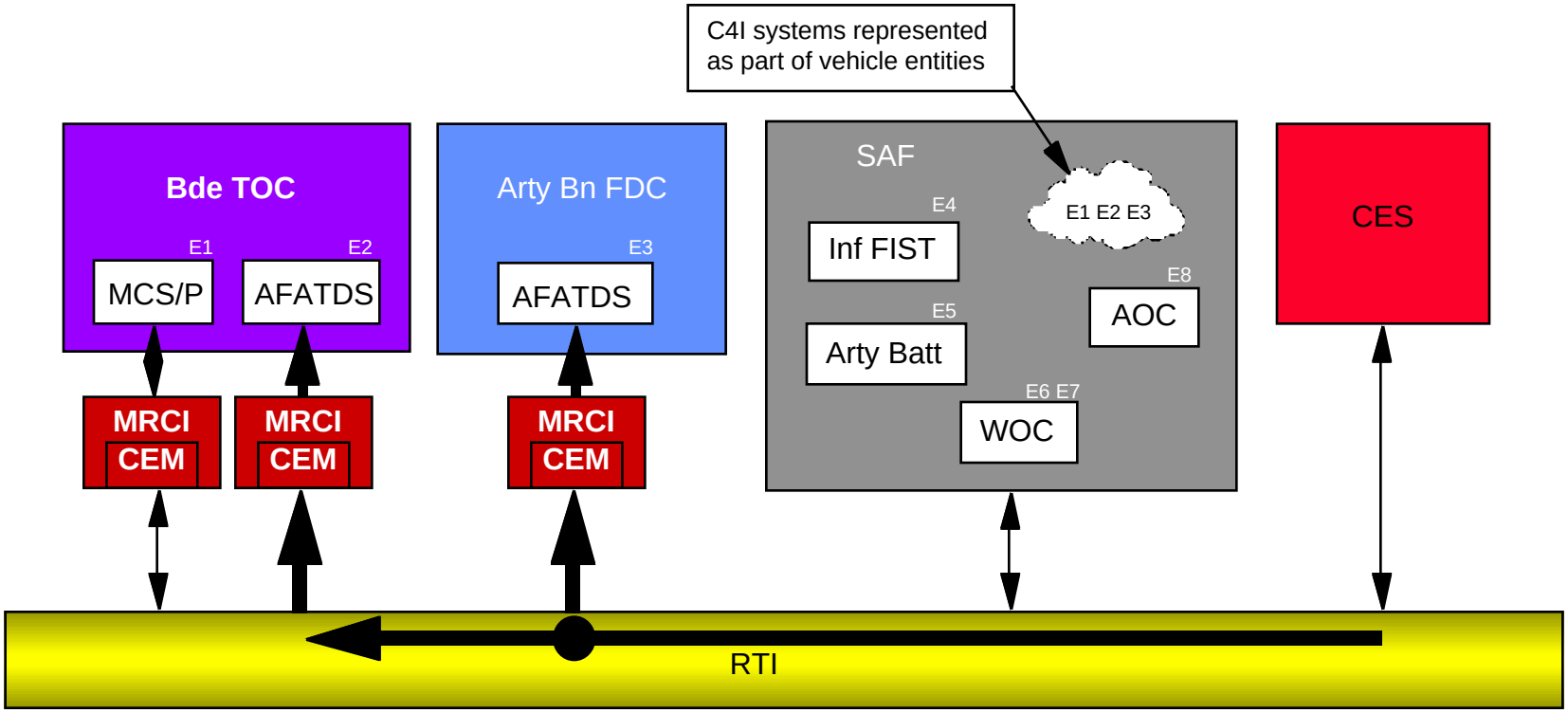
Basic Concept- Part II

3) Each Communications Effects Module (CEM- incorporated within each MRCI) holds the message until either:
   a) It receives a Latency Time (LT) from the Communications Effects Server (CES)
      OR
   b) A maximum LT value expires, in which case the message is released (in this example the max LT value does not expire).
4) The CES runs the message through its communications model and generates an expected time of arrival (referred to as the LT). It then sends the LT (along with unique message and receiver identifiers) as an interaction via the RTI.



Basic Concept- Part III

5) The LT interaction is received by every subscribing MRCI. It is only used when the held message corresponds to the LT's receiver and message ID.
6) The CEM (resident in the MRCI) releases the message when the LT expires.



The Three Key Components of the CESS

Communications Object

Purpose:
- Adequately represents communications device
- Facilitates dissemination of changes in attributes

Used by:
- CES as communications determinant
- CEMs as most basic communications determinant

Maintained and updated by:
- Creating federate upon initialization and attribute changes

Max. Latency Time (LT) Matrix Interaction

Purpose:
- Sender/receiver pair locates time value in matrix- used as coarse time release value
- Backup for LT interaction (if processing + transport of LT > max. time value then release message

Used by:
- CEM as coarse message release determinant

Generated and sent by:
- CES upon initialization and when significant change in comm state occurs

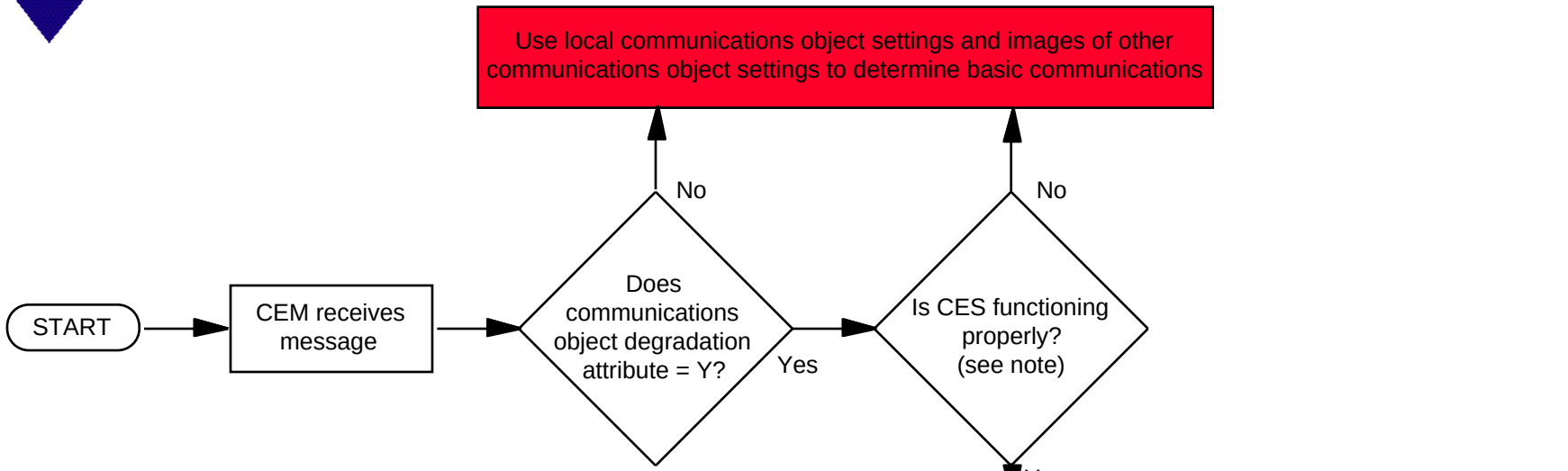
Latency Time (LT) Interaction

Purpose:
- Contains value that accurately represents simulated time of message delivery
- Determines when CEM releases message

Used by:
- CEM to accurately determine message release time

Generated and sent by:
- CES upon receipt of message

CEM Message Decision Tree



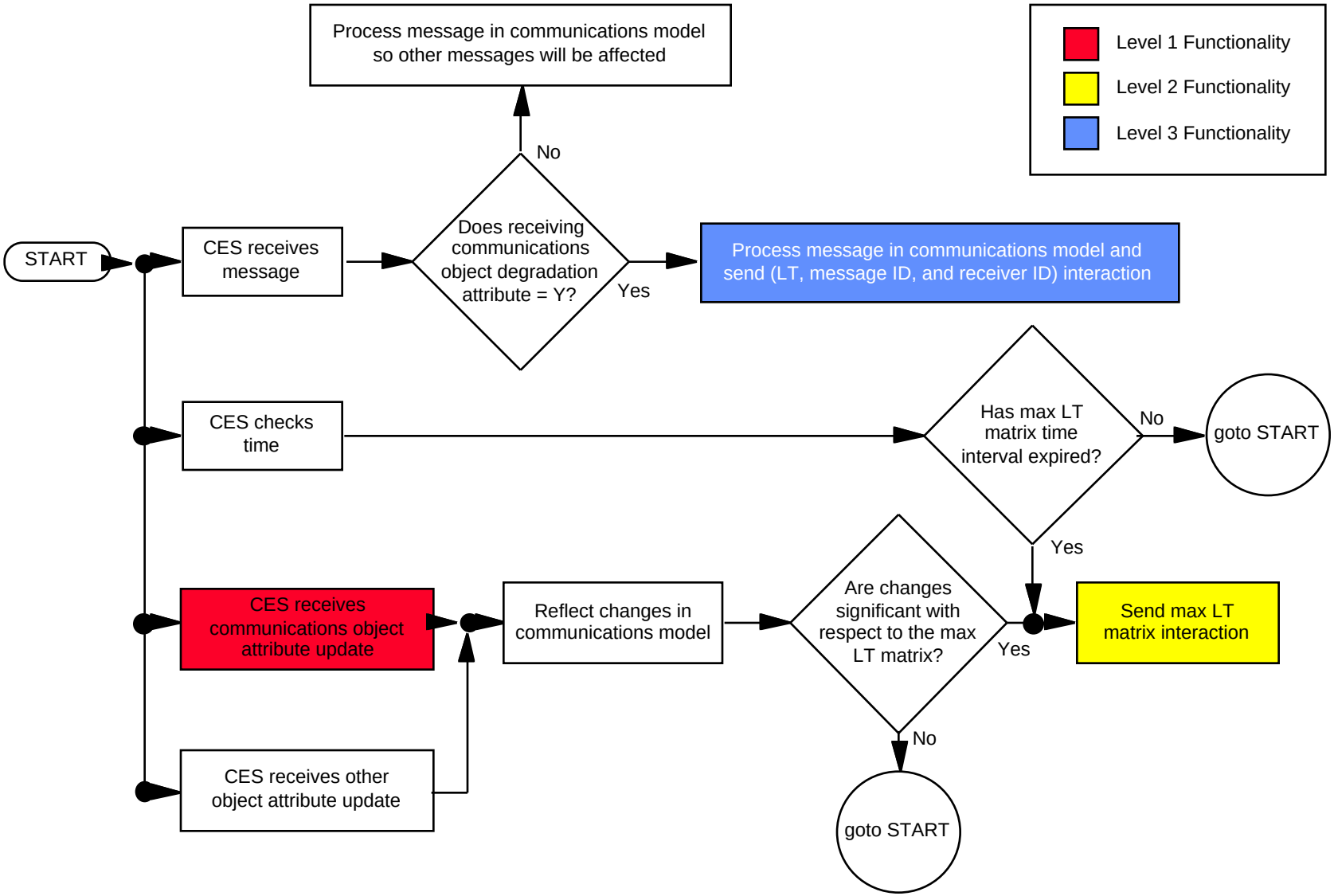
Level 1 Functionality
- No degradation applied
- Basic communication determined by communications object settings (i.e. frequency, crypto system, crypto key)

Level 2 Functionality
- Basic communication applied via LT matrix
- Coarse degradation value applied
- Used to check for high-speed communication link (i.e. TOC connection)
- Used as backup for excessive CES and/or RTI delivery latency

Level 3 Functionality
- Basic communication applied via LT value
- Accurate degradation applied

note: A properly functioning CES will have delivered an LT matrix within a fixed interval of time. Also, no recurring CES related errors exist (i.e. LT value not received 5 times)

CES Functional Decision Tree



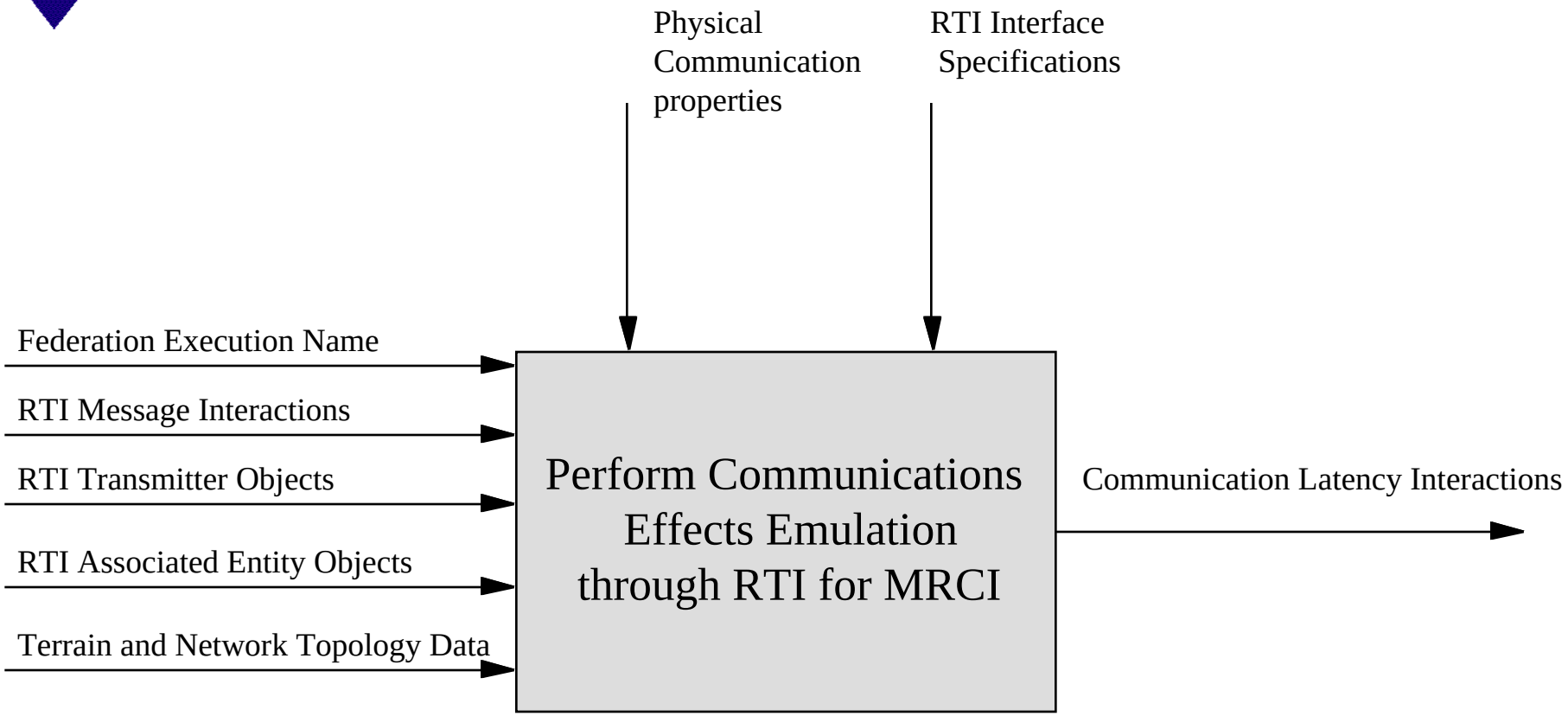
Glossary

Term	Abbreviation	Definition
Communications Effects Server	CESS	The general name given to the modular server System system used to apply tactical communications effects in a simulated environment.
Communications Effects Server	CES	A system that monitors aspects related to communications and generates degradation parameters on a per message basis.
Communications Effects Module	CEM	A module incorporated within a system that determines message delivery based on communications object settings or degradation parameters received from the CES.
Latency Time	LT	The delayed time of delivery of a message (base time = RTI federation time). Sent by CES as an interaction and received by CEM.
Maximum Latency Time Matrix	Max LT matrix	A matrix populated by values representing the maximum latency incurred on message delivery. Values are identified by sender/receiver pairs.
Maximum Latency Time Value	Max LT value	The value obtained when a sender/receiver pair is applied to the max LT matrix.

Draft Phase 1 Functional Decomposition

- Perform Communications Effects Emulation
  - **Subscribe to all message interactions, transmitter object class attributes and associated entity object class attributes through the RTI (CRI)**
    - Subscribe to Message interactions
    - Subscribe to transmitter object attributes
    - Subscribe to associated entity object attributes
  - **Track all transmitter objects, message interactions and associated entity objects from the RTI and update CMM communications model (CRR)**
    - Track Message interactions and update Comm Model with relevant info
      - Receive
      - Update Relevant info
    - Track transmitter and associated entity objects and update Comm Model with relevant info
      - Receive
      - Update Relevant Info
  - **Model communications latency for message interactions (CMM)**
    - Receive Message interactions and Object attribute info from CRR
    - Model Communications Effects using transmitter Objects, Associated Entities and Interactions
    - Calculate LT's for specific message interaction requiring LT's
    - Send Unique message ID, Latency Times (LT's) and Receivers to CRP
  - **Send communications latency interaction to receiving transmitter object (CRP)**
    - Create Communications latency interaction
    - Send Comm latency interaction to RTI
  - **Terminate Communication Effects Server (CRT)**
    - Resign Federation Execution

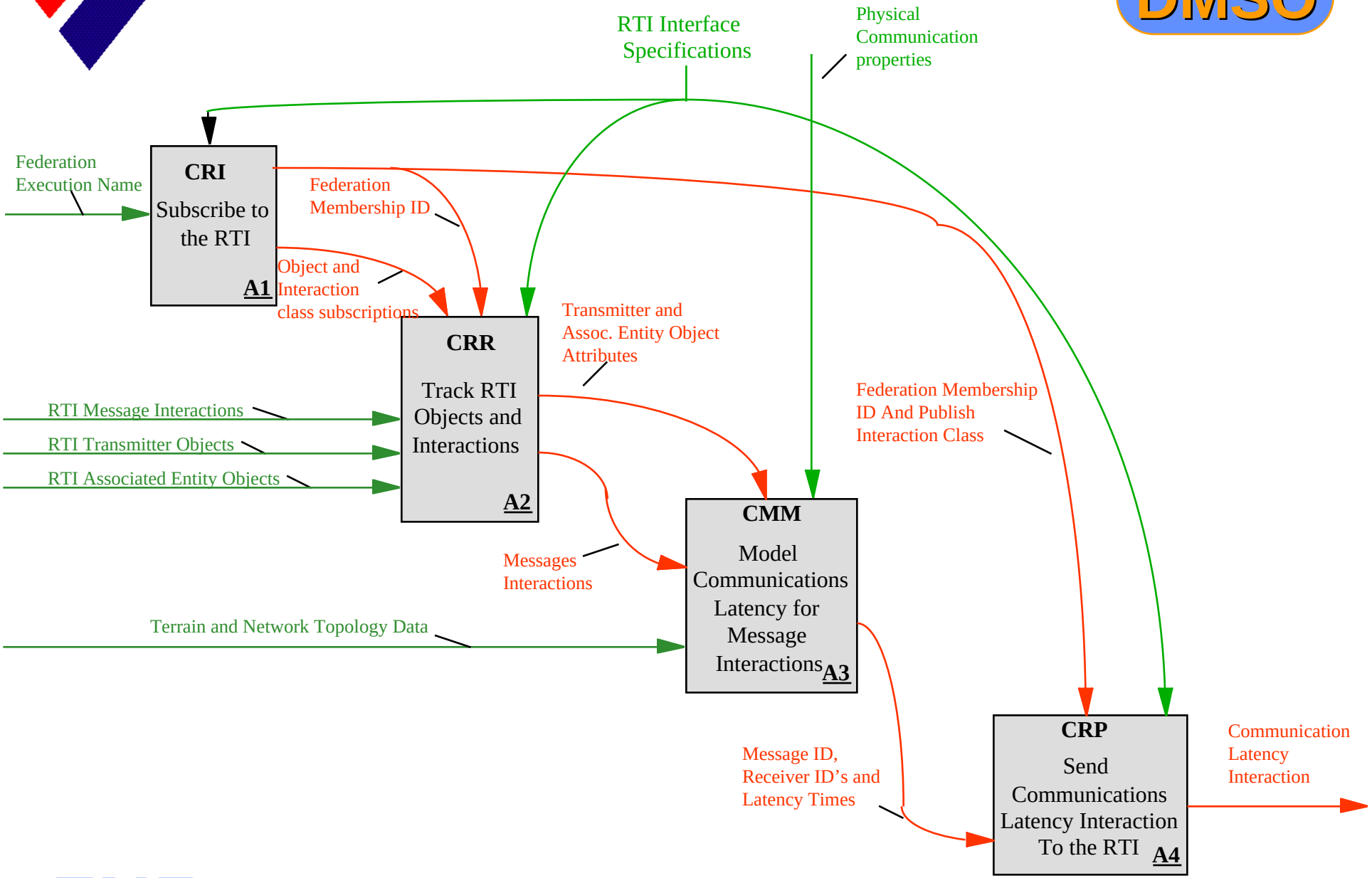
CES Process Model IDEF-0 A -1 Diagram



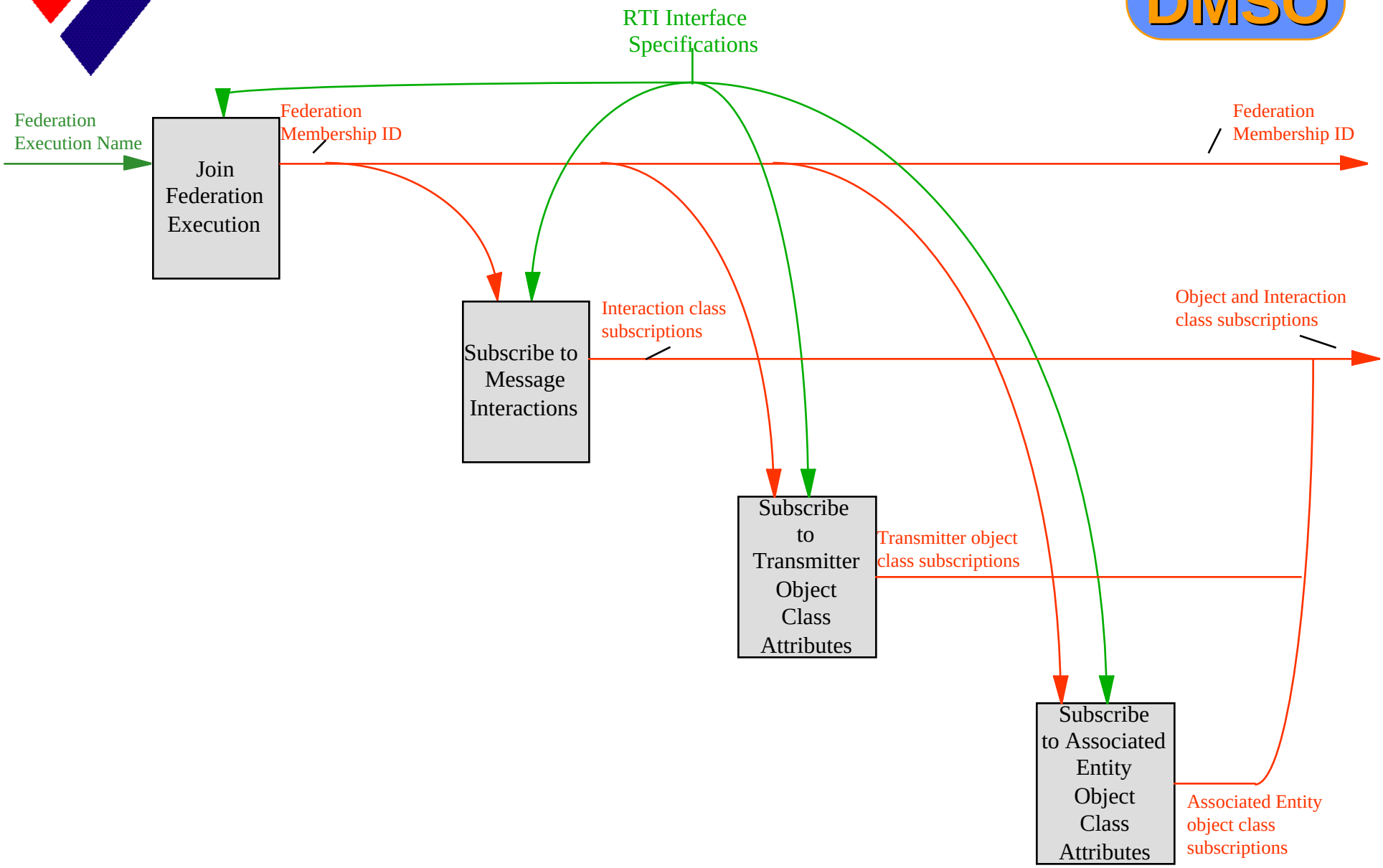
Purpose: To model the effects of a simulated communications network on real world networks

Viewpoint: System Architect

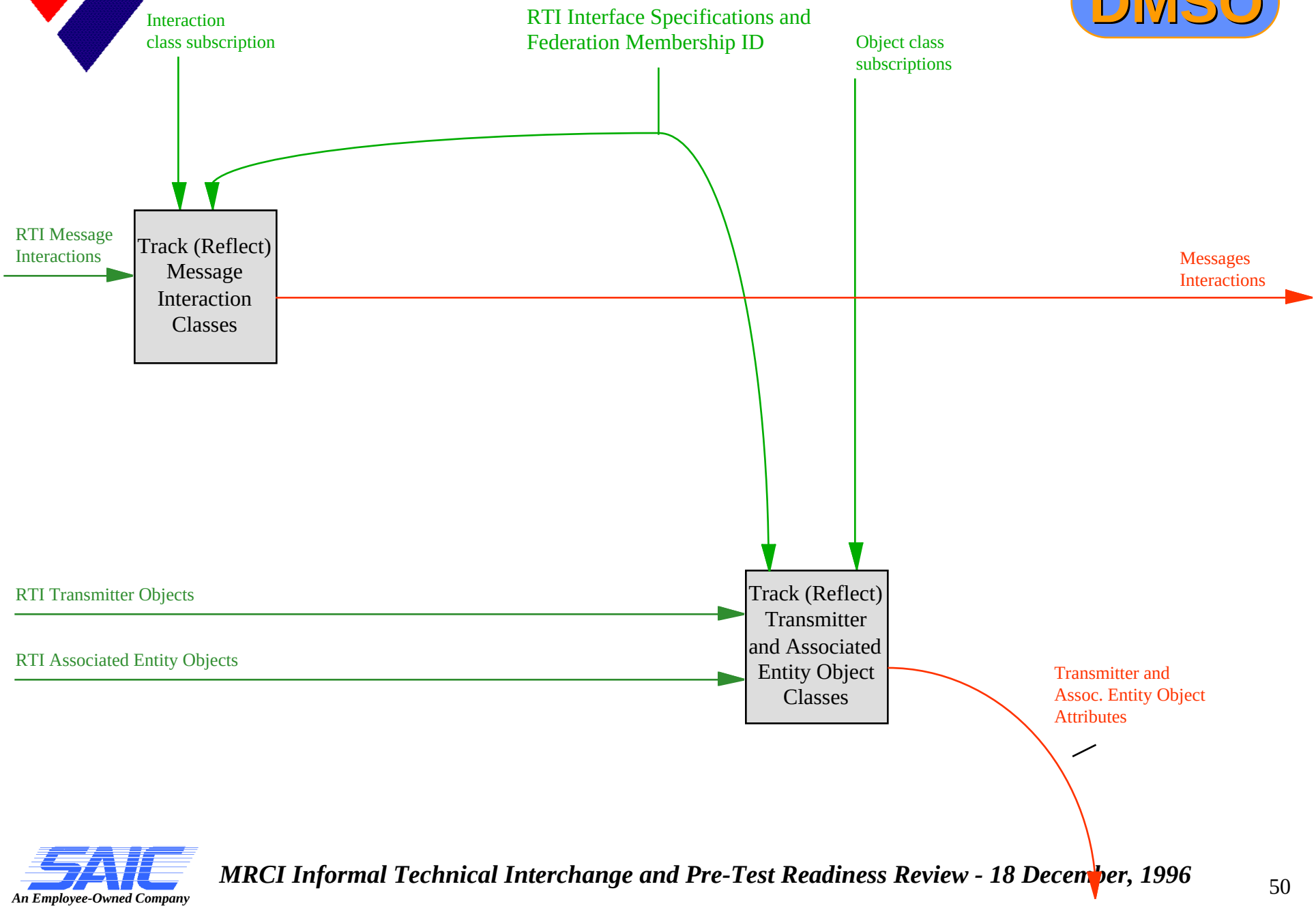
CES Process Model IDEF-0 A- 0 Diagram



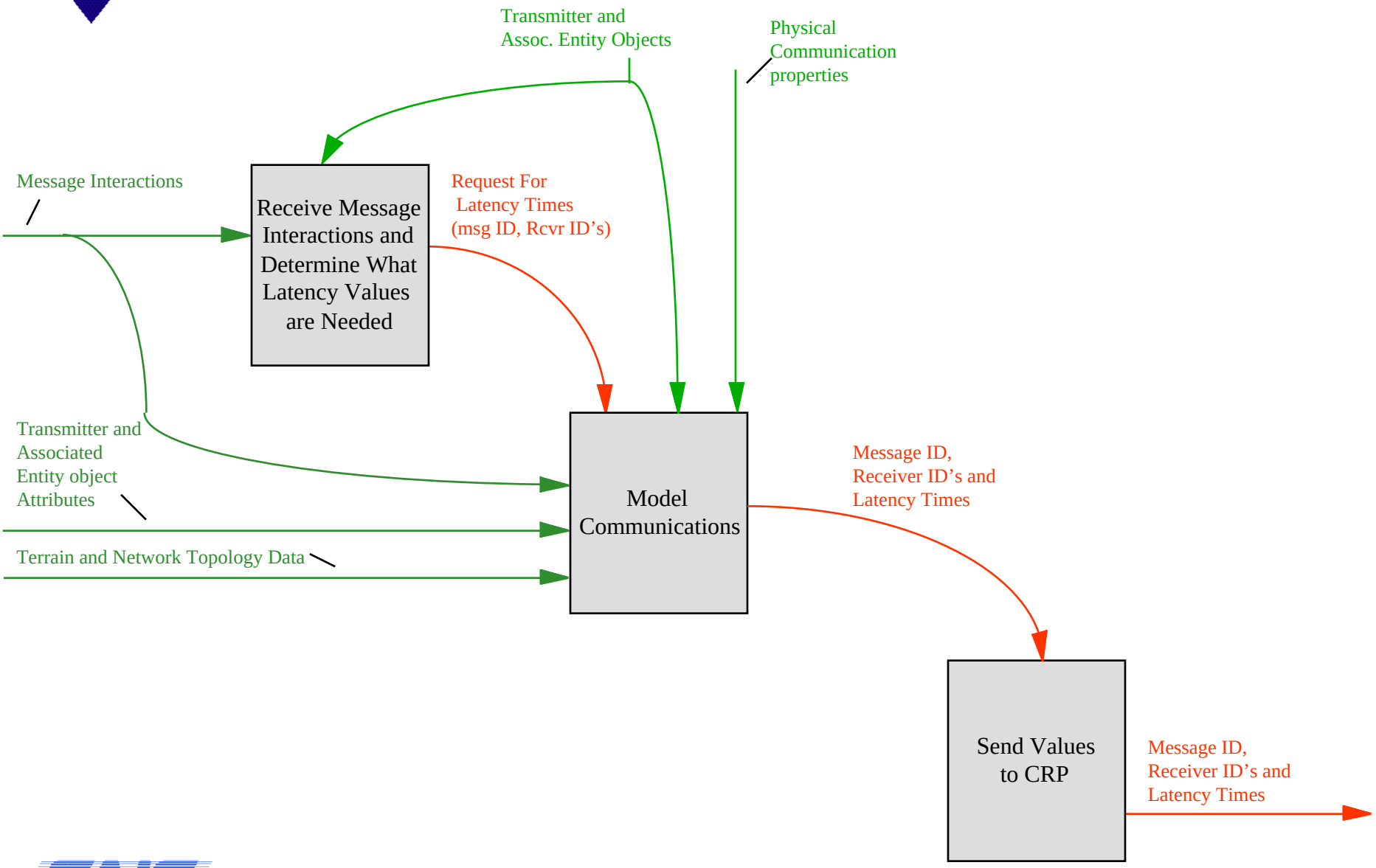
CES Process Model IDEF-0 A1 Diagram



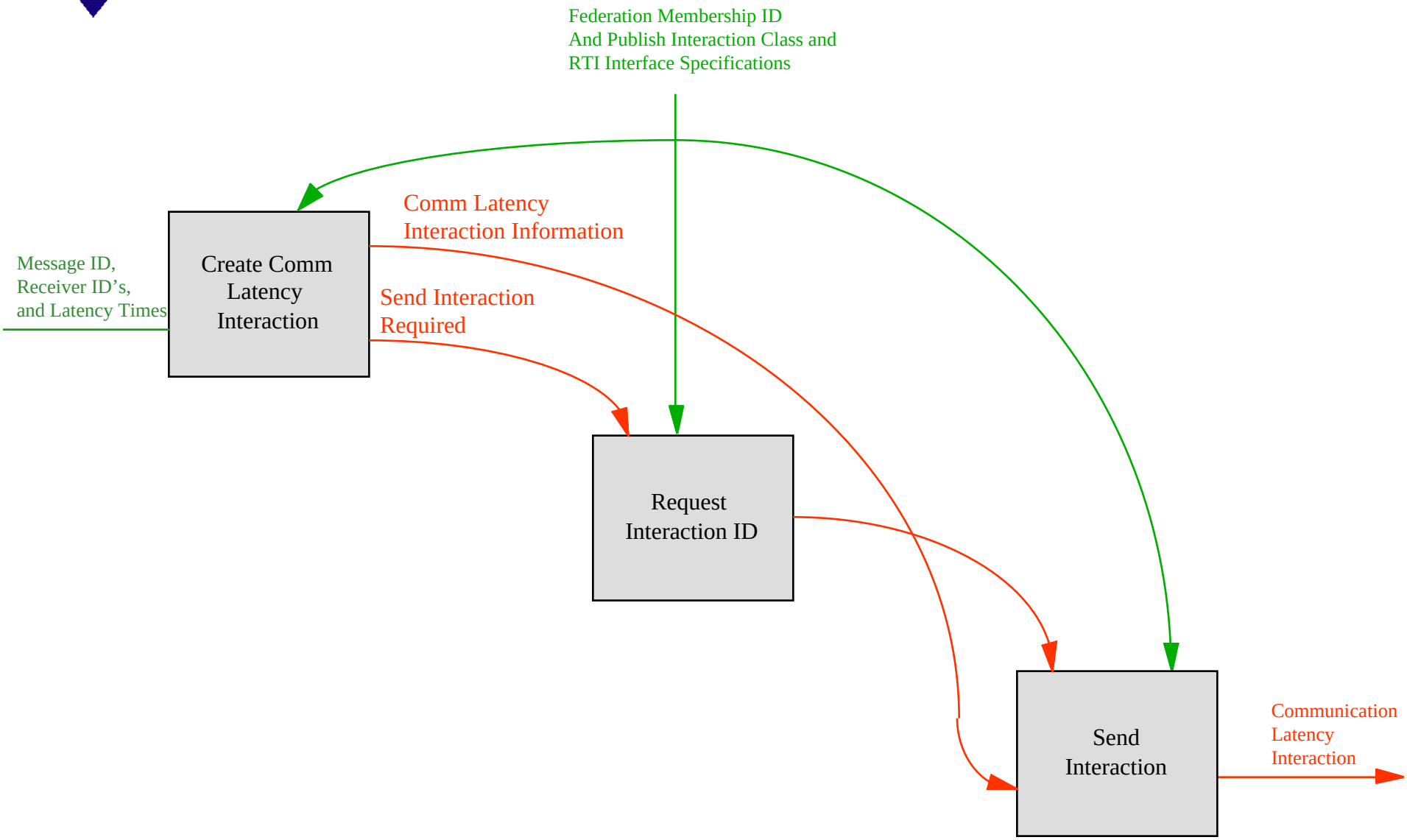
CES Process Model IDEF-0 A2 Diagram



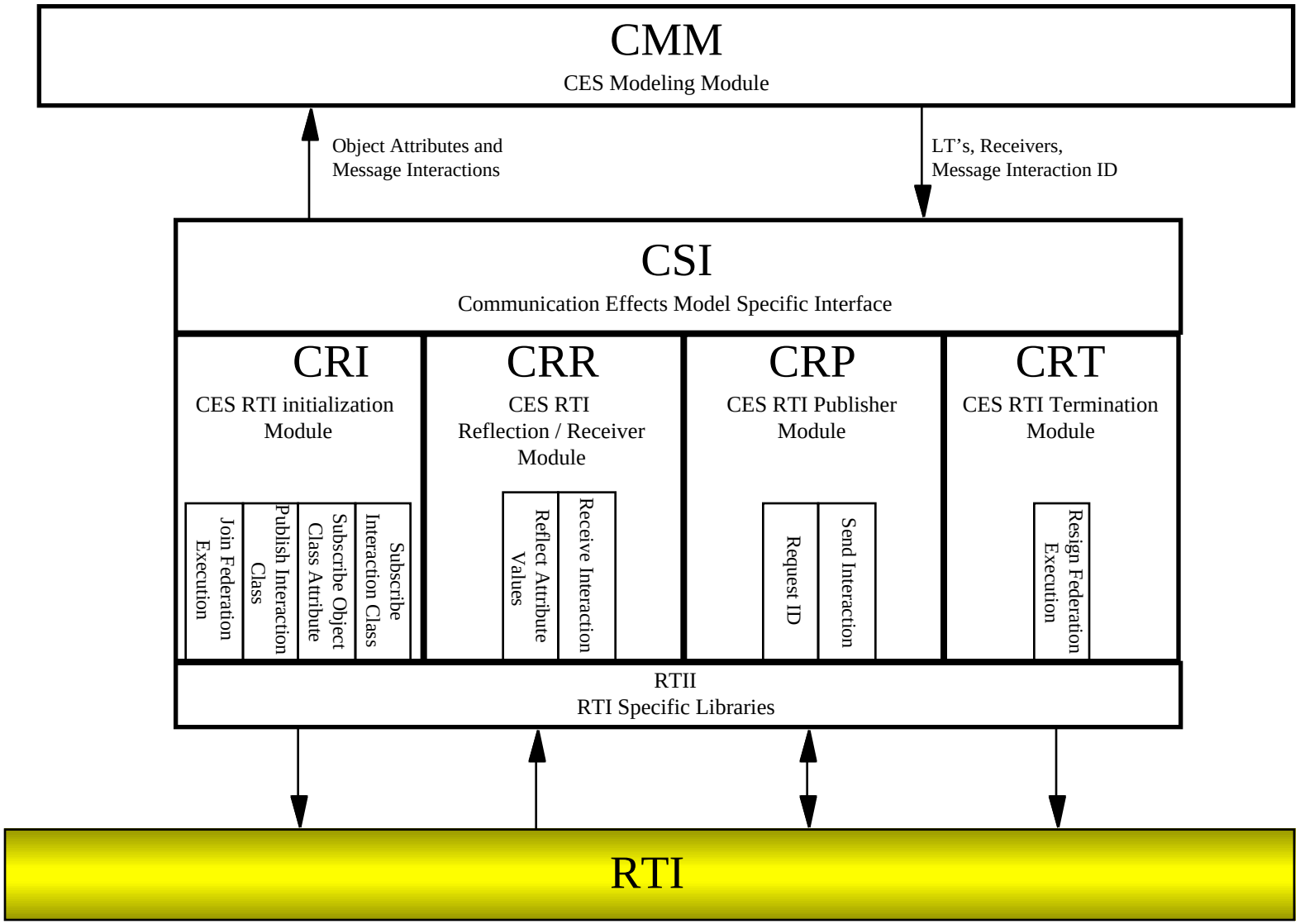
CES Process Model IDEF-0 A3 Diagram



CES Process Model IDEF-0 A4 Diagram



Software Module Design for CES



Draft CES Federate Requirements

Requirements for the CES - CEM (Server - Module) System Phase 1 Build

- The CES will join an RTI federation, subscribe to object attributes and message interactions, and Publish Interaction class (Latency Time (LT) interaction)
- The CES will receive object class attributes relevant* to the Communications model (CMM), reflect changes, and receive Message interactions.
- The CES will make object attributes and reflected changes relevant to the Communications model available to the Communications model (CMM)
- The CES will make all message interactions available to the Communications Model (CMM) to model transmissions.
- The CES will receive LTs and receiver and unique message IDs from the communications model for creating Latency Time Interaction
- The CES will Publish an LT interaction for each message received from the RTI destined for all communications objects with the "Apply Degradation" attribute set to "on." The form will be an interaction consisting of:
    - Unique Message ID
    - Latency Time
    - Receiver ID

* "Relevant information" is TBD and will include at least the following information:

- Transmitters ID
- Locations of Transmitters
- Radio State (on/off, encrypt, power, type, etc…TBD)

Draft CEM Requirements

Requirements for the CES - CEM (Server - Module) System Phase 1 Build

- The Communications Effects Module (CEM) will receive messages from the MCM (MRCI Message handler).
- The CEM will:
  - Pass messages if local transmitter object attribute “Apply Degradation” is “off”
  - Enque messages if local transmitter object attribute “Apply Degradation” is “on
- The CEM will monitor Latency Time (LT) interactions
- The CEM will monitor enqued objects by unique message ID
- The CEM will receive LT for all enqued messages by comparing LT interaction value “Unique message ID” to enqued messages Unique Message ID, and comparing LT interaction Receiver ID with the module's receiver ID (is the LT for this message; is it for me?).
- When a match is found, the CEM will pass the message only when the federate time is later than the latency time (LT).
- The CEM will pass messages when the federate time is later than the federation time of message receipt plus a Maximum Latency Time Value. (set to 30 seconds for Phase 1)
- CEM will compare sender/receiver transmitter objects for message interactions to determine basic comms in absence of CES. Specific attributes to match are TBD.

Draft CMM Requirements

Requirements for the Communications Model Phase 1 and 2 Builds

- **Phase 1 Requirements**
  - (1.1) The CMM will receive message interactions.
  - (1.2) The CMM will return an LT value based on a static representation of the transmitter objects (e.g. values read from a static file mapping transmitting objects to an LT value) for all messages destined for receivers with “Apply Degradation” = on
- **Phase 2 Requirements**
  - (2.1) The CMM will Monitor transmitter object attributes and associated entity object attributes
  - (2.2) The CMM will Monitor message interactions and account for RTI CCSIL or C4I messages actual “in the field” transmission protocol for transmission size representation
  - (2.3) The CMM will have an interface to all terrain data applicable to all federates in any exercise
  - (2.4) The CMM will have an interface to all network topology data applicable to all federates in any exercise
  - (2.5) The CMM will use *transmitter object attributes, associated entity attributes and state, message interactions (that represent transmissions), terrain data, and network topology data* to accurately (within 10% of real life values) and promptly (<250 milliseconds) represent delay times for any specific message interaction and all receivers at any time, using physical properties of communications including terrain effects and Combat Net Radio w/ SINCGARS-SIP radios.
  - (2.6) The software construction will be C++, compilable on a Sun SPARC 20 running Solaris 2.5, and modular to allow for future inclusion of weather , electromagnetic, jamming, and other effects.

CES and CMM Phase 1 Functionality

- **Communications Effects Module (CEM)**
  - CEM will be able to compare communications objects to determine basic communication.
  - CEM will be able to enque messages when degradation is set to “on” and wait for an LT or for a static timeout value to expire
  - CEM will pass messages upon timeout
- **Communications Effects Server (CES)**
  - The CES will be able to join a federation execution
  - The CES will be able to subscribe to interactions.
  - The CES will be able to subscribe to communications object classes and reflect updates to objects.
  - The CES will be able to publish the Latency Time Interaction.
  - The CES will be able to update the CMM with message interactions and object attributes and updates
  - The CES will be able to receive an LT, Unique Message ID and receiver from the CMM
  - The CES will be able to construct the LT interaction from the CMM’s provided information
- **Communications Modeling Module (CMM)**
  - The CMM will be able to receive message interactions and object attributes and updates from the CES.
  - The CMM will be able to return an LT, unique message ID and Receiver ID to the CES for each message bound for a receiver with degradation set to “on” (for each receiver.)

CESS Phase 2 Functionality

- **CEM**
  - CEM will be able to compare communications objects to determine basic communication.
  - The CEM will be able to receive the Max_LT_Interaction and from it obtain the max LT value
  - CEM will be able to enque messages when degradation is set to “on” and wait for an LT or for the sender / receiver pair value in the Max_LT_Interaction to timeout
  - CEM will pass messages upon timeout
  - The CEM will maintain a log of time received / time passed / LT for each message received
- **CES**
  - The CES will be able to join a federation execution
  - The CES will be able to subscribe to interactions.
  - The CES will be able to subscribe to communications object classes and reflect updates to objects.
  - The CES will be able to publish the Latency_Time and Maximum_Latency_Time Interactions
  - The CES will be able to update the CMM with message interactions and object attributes and updates
  - The CES will be able to receive an LT, Unique Message ID and receiver from the CMM
  - The CES will be able to construct the LT interaction from the CMM provided information
  - The CES will either receive a Maximum_Latency_Time_Interaction from the CMM or create one
  - The CES will be able to publish a Maximum_Latency_Time_Interaction when created or received

CMM Phase 2 Functionality

- **CMM**
  - The CMM will be able to receive message interactions and object attributes and updates from the CES.
  - The CMM will be able to return an LT, unique message ID and Receiver ID to the CES for each message bound for a receiver with degradation set to “on”, for each receiver
  - The CMM will be able to provide the CES values for creating a Max_LT_Matrix Interaction, including senders / receivers, and Max_Latency_Time based on an algorithm TBD.
  - The CMM will Monitor transmitter object attributes and associated entity object attributes
  - The CMM will Monitor message interactions and account for RTI CCSIL or C4I messages actual transmission protocol for transmission size representation
  - The CMM will have an interface to all terrain data applicable to all federates in any exercise
  - The CMM will use *transmitter object attributes, associated entity attributes and state, message interactions (that represent transmissions),and terrain data* to accurately (within 10% of real network values) and promptly (<250 milliseconds) represent delay times for any specific message interaction and all receivers at any time, using physical properties of communications including terrain effects and Combat Net Radio w/ SINCGARS-SIP radios.

ITI/PTRR Agenda (2 of 3)

Time	Subject
1020-1045	Translator Implementation
	- Overview of Operation and Initialization
	- Protocol Table Generation
	- Uniform Message Structure of Protocol Tables
	- Parsers
	- Mapping File Syntax
	- Examples of USMTF to CCSIL Mapping File
1045-1125	Communications Representation in SOMs
	- Communications Degradation Work in Progress and Current Status
1125-1140	Effects of Different Federations and RTIs on MRCI Reusability
	- Extent that MRCI is Customized for STOW and HLA C2
	- Extent that MRCI uses the same Software
	- RTI Interface Implementation Activities

Extent that MRCI is Customized for STOW and HLA C2

STOW

- RTI version STOW A.
- *Currently* only supports a generic Signal Interaction rather than individual CCSIL Interactions (for compatibility with ModSAF).
- Initializes Communications Radio Network via a file.
- Does not support Ownership functions (MRCI must create its own command and communications objects).

HLA C2

- RTI version F.0.
- Will support CCSIL Interactions.
- Communications Setup To Be Determined.
- Will support Ownership functions.

Reusability of Current MRCI Software

- SSI API is common
- RTI interface will accommodate different RTI versions
- Parsers for USMTF/ATCCS/TACFIRE are common
- Translator module is completely independent of Federation/C4I system/RTI issues
- Mapping files can be used between exercises

RTI Interface Implementation Activities

- Integrated RTI 0.33a into MRCI MCS/P CCTT Prototype.
- Integrated STOW RTI A.1 into ITSEC MRCI Demo.
- Integrated STOW RTI A.2 into Baseline MRCI for CT-4.
- Will Integrate RTI F.0 into Baseline MRCI for HLA C2 (released Dec 96).
- Will Integrate STOW RTI B.0 into Baseline MRCI for CT-5 (released Dec 96).
- Will continue to integrate future version of RTI to support experimentation in 1997.

ITI/PTRR Agenda (3 of 3)

Time	Subject
1140-1150	Current Test Schedules and Assessment Activities
	- Alignment with STOW
	- Alignment with HLA C2
	- MRCI Assessment Schedule [Multiple Constraint Version]
1150-1200	MRCI Master Activity Schedule
	- Re-issuance of C4I Federate SOMs [MCS, AFATDS, CTAPS]
1200	Adjourn

ITI/PTRR Agenda (3 of 3)

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ITI/PTRR Agenda (3 of 3)

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1200	**Adjourn**